UNITED STATES DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

DRAFT FAA-E-2937A

SPECIFICATION

PERFORMANCE TYPE ONE
LOCAL AREA AUGMENTATION SYSTEM
GROUND FACILITY

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1. SCOPE

1.1 IDENTIFICATION

This specification establishes the performance requirements for the Federal Aviation Administration (FAA) Performance Type (PT) 1 Local Area Augmentation System (LAAS) Ground Facility (LGF). Requirements contained within this specification are the basis to augment the Global Positioning System (GPS) to provide precision approach capability down to Category I minimums. The performance requirements are consistent with those requirements defined in the Requirements Document for the GPS Local Area Augmentation System (GPS/LAAS) (FAA, 1997), the Minimum Aviation System Performance Standards (MASPS) for the LAAS (RTCA/DO-245, 1998), and the Minimum Operational Performance Standards (MOPS) for the LAAS (RTCA/DO-253, 2000). Some functional requirements are embedded in the LGF performance requirements.

1.2 SYSTEM OVERVIEW

The LGF is a safety-critical system consisting of the hardware and software that augments the GPS Standard Positioning Service (SPS) providing precision approach and landing capability in the United States National Airspace System (NAS). The current GPS positioning service provided is insufficient to meet the integrity, continuity, accuracy, and availability demands of precision approach and landing navigation. The LGF, using differential GPS concepts, augments the GPS SPS in order to meet these requirements.

As an integrated system, the GPS/LAAS is maintained in three separate segments (illustrated in Figure 1-1): a) the LGF; b) the Space Segment; and c) the Airborne Subsystem. The LGF provides differential corrections, integrity parameters, and precision approach pathpoint data that are broadcast via a Very High Frequency (VHF) Data Broadcast (VDB) to the Airborne Subsystem for processing. The Space Segment provides the LGF and Airborne Subsystem with GPS and Satellite-Based Augmentation System (SBAS) ranging signals and orbital parameters. The Airborne Subsystem applies the LGF corrections to the GPS and SBAS ranging signals to obtain position with the required accuracy, integrity, continuity, and availability. The differentially corrected position is used, along with pathpoint data, to supply deviation signals to drive appropriate aircraft systems supporting precision approach.

The LGF provides FAA Airway Facilities and Air Traffic with detailed status information and a maintenance and control capability. Status and control capabilities are executed through either a Maintenance Data Terminal (MDT) or a Remote Maintenance Data Terminal (RMDT). The MDT display is provided as part of the LGF, while the RMDT will allow for future integration with a remote maintenance monitoring capability. Additionally, the LGF sends status information to FAA Air Traffic Control (ATC) via an Air Traffic Control Unit (ATCU). The ATCU provides air traffic controllers with LGF status information and runway control capabilities. For maintenance purposes, LGF status information is available via the Local Status Panel (LSP) and the Remote Status Panel (RSP).

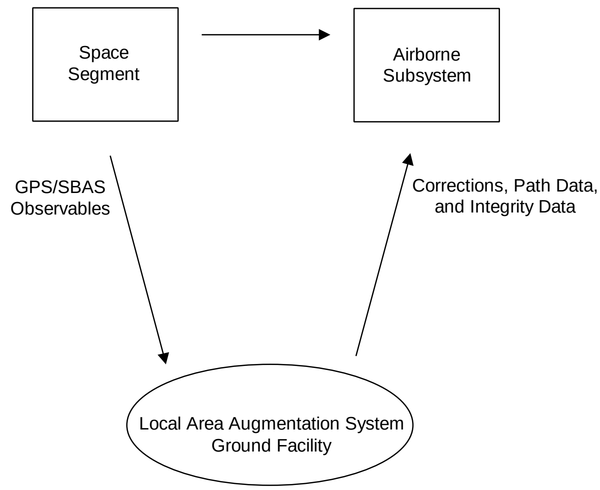

Figure 1-1. Local Area Augmentation System

1.3 DOCUMENT OVERVIEW

The format of this document complies with FAA-STD-005E, MIL-STD-961D, and MIL-STD-962C. Section 1 provides a general overview of the LGF and a high-level introduction to the requirements for implementing operational satellite-based precision approach. Section 2 lists the documents from which requirements are referenced or derived. Section 3 contains the performance, functional, operational, and maintenance requirements for the LGF. Section 4 contains verification requirements for both hardware and software. Appendix A contains details of the Interference Environment. Appendix B provides Configuration Management and Quality Control conditions. Appendix C is the Verification Requirements Traceability Matrix. Appendix D supplies a listing and expansion of acronyms. Appendix E provides information on the Assumed Airborne Processing. Appendix F supplies information on the operational environment to aid in proper integration with existing facilities and procedures. Appendix G provides the Integrity Risk and Continuity Risk Allocation trees. Exceptions to RTCA/DO-246A are contained in Appendix H. The definitions for the Final Approach Segment are located in Appendix I. Appendix J provides a listing of documents normally required for a government-procured the LGF.

2. APPLICABLE DOCUMENTS

The following documents form a part of this specification and are applicable to the extent specified herein. In case of conflict between referenced documents and the contents of this specification, the contents of this specification shall take precedence.

2.1 GOVERNMENT DOCUMENTS

2.1.1 SPECIFICATIONS

2.1.1.1 Federal Aviation Administration

Federal Aviation Administration. (1993). *Electronic equipment, general requirements* (FAA-G-2100F). Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (1996). *Electrical work, interior* (FAA-C-1217F). Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (1975). *Technical instruction book manuscripts: electronic equipment requirements for part - preparation of manuscript* (FAA-D-2494B). Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (1997). *Wide area augmentation system (WAAS) specification* (FAA-E-2892B). Washington, DC: U.S. Government Printing Office.

2.1.1.2 Department of Transportation

Department of Transportation. (1995). *GPS standard positioning service (SPS) signal specification*.

2.1.2 STANDARDS

2.1.2.1 Federal Aviation Administration

Federal Aviation Administration. (1991). *Standard engineering drawing preparation and support* (FAA-STD-002). Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (1996). *Design standards for national airspace system physical facilities* (FAA-STD-032D). Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (1962). *Paint systems for structures* (FAA-STD-003). Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (1994). *Quality control program requirements* (FAA-STD-013D). Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (1996). *Standard practice preparation of specifications, standards and handbooks* (FAA-STD-005e). Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (1992). *Transient protection, grounding, bonding and shielding requirements for electronic equipment* (FAA-STD-020B). Washington, DC: U.S. Government Printing Office.

2.1.2.2 Military

Department of Defense. (1997). *Configuration management guidance* (MIL-HDBK-61). Washington, DC: U.S. Government Printing Office.

Department of Defense. (1995). *Department of defense standard practice for defense specifications* (MIL-STD-961D). Washington, DC: U.S. Government Printing Office.

Department of Defense. (1995). *Department of defense standard practice defense standards and handbooks* (MIL-STD-962C). Washington, DC: U.S. Government Printing Office.

2.1.3 FAA ORDERS

Federal Aviation Administration. (1998). *Electrical power policy implementation at national airspace system facilities* (FAA Order 6950.2D). Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (1999). *Federal aviation administration information systems security program* (FAA Order 1370.82 Draft Version, dated 7/29/99). Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (1991). *General maintenance handbook for airway facilities* (FAA Order 6000.15B). Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (1991). *NAS configuration management* (FAA Order 1800.8F). Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (1983). *Radiation health hazards and protection* (FAA Order 3910.3A). Washington, DC: U.S. Government Printing Office.

2.1.3.1 Other Government Documents

National Institute of Science and Technology. (1999). *CS2 protection profile for near-term COTS*. Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (2000). *LAAS concept of operations*. Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (1985). *Obstruction marking and lighting* (FAA AC 70/7460-1J). Washington, DC: U.S. Government Printing Office

Federal Aviation Administration. (1997). *Requirements document for the GPS local area augmentation system (GPS/LAAS)*. Washington, DC: U.S. Government Printing Office.

Federal Aviation Administration. (1986). *Specification for obstruction lighting equipment* (AC 150/5345-43E). Washington, DC: U.S. Government Printing Office.

2.2 NON-GOVERNMENT DOCUMENTS

International Civil Aviation Organization. (1999). *Ground based augmentation system standards and recommended practices*. Proceedings of the Global Navigation Satellite System Panel (GNSSP) Third Meeting, Montreal, Canada 12 to 23 April 1999, Report on Agenda Item 1.

International Civil Aviation Organization. (2000). *Ground based augmentation system standards and recommended practices*. Proceedings of the Global Navigation Satellite System Panel (GNSSP) Working Group B Meeting, Seattle, Washington, USA 29 May to 9 June, Report of the ICAO GNSSP Working Group B Meeting.

RTCA, Incorporated. (2000). *GNSS based precision approach local area augmentation system (LAAS) signal-in-space interface control document* (RTCA/DO-246A). Washington, DC: RTCA, Incorporated.

Electronic Industries Association. (1991). *Interface between data terminal equipment and data circuit-terminating equipment employing serial binary data interchange* (EIA/TIA-232-E).

Electronic Industries Association. *National consensus standard for configuration management* (EIA-649).

National Fire Protection Association. (1996). *NFPA 70, national electrical code* (1996 ed.). Quincy, MA: National Fire Protection Association.

RTCA, Incorporated. (2000). *Minimum operational performance standards for global positioning system/local area augmentation system airborne equipment* (RTCA/DO-253). Washington, DC: RTCA, Incorporated.

RTCA, Incorporated. (1998). *Minimum operational performance standards for global positioning system/wide area augmentation system airborne equipment* (RTCA/DO-229A). Washington, DC: RTCA, Incorporated.

RTCA, Incorporated. (1998). *Minimum aviation system performance standard for the local area augmentation system (LAAS)* (RTCA/DO-245). Washington, DC: RTCA, Incorporated.

RTCA, Incorporated. (1993). *Software considerations in airborne systems and equipment certification* (RTCA/DO-178B). Washington, DC: RTCA, Incorporated.

3. REQUIREMENTS

This section prescribes functional and performance requirements. Functional requirements, and their groupings, do not imply allocation of functionality to hardware and software design. No design or algorithms are specified, except where required to establish interoperability.

3.1 LGF GENERAL REQUIREMENTS

3.1.1 COVERAGE VOLUME

The LGF approach coverage volume is defined as the volume of airspace where the LGF meets the signal strength, accuracy, integrity, continuity, and availability requirements of this specification. The LGF will provide the level of service necessary to support Category 1 operations to all runways at a given airport. The VDB is required to broadcast an omnidirectional signal to accommodate terminal and surface navigation, surveillance, and other users requiring Position, Velocity, and Time (PVT) information, but may be limited by the existence of terrain or obstacles on or around the airport.

3.1.1.1 Approach Coverage Volume

When the installed on-channel assigned power is set to the lower monitor limit, the LGF shall meet the minimum field strength requirements of Section 3.2.2.4 for each Category 1 approach (depicted in Figure 3-1). The approach and missed approached coverage volume shall be:

a. Approach:

   1. Laterally beginning at 450 ft each side of the Landing Threshold Point (LTP) or Fictitious Threshold Point (FTP) and projecting out ± 35° either side of the final approach path to a distance of 20 nm from the LTP/FTP.

   2. Vertically, within the lateral region, between 10,000 ft Above Ground Level (AGL) and the plane inclined at 0.9° originating at the LTP/FTP and down to 50 ft above the runway.

b. Missed Approach:

   1. Laterally ± 1.0 nm either side of the runway centerline from the approach end of the runway to 4.0 nm beyond the departure end of the runway.

   2. Vertically, within the lateral region, between 10,000 ft AGL and the plane inclined at 0.9° above the horizontal plane and passing 50 ft above the LTP/FTP level along a horizontal plane to the Flight Path Alignment Point (FPAP), then continuing along a horizontal plane inclined at 0.9°.

Note: Missed approach coverage may be affected by the siting of the VDB antenna.

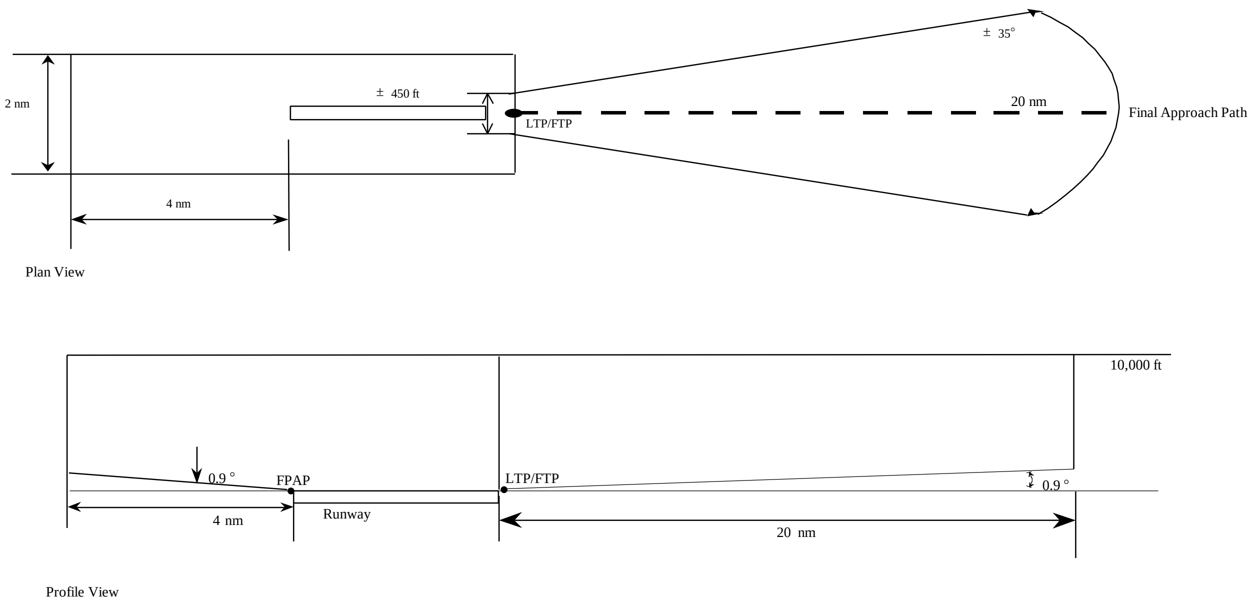

Figure 3-1. Approach Coverage Requirements

3.1.1.2 VDB Coverage Volume

3.1.1.2.1 Lower Alarm Limit

The LGF shall meet the minimum field strength requirements of Section 3.2.2.4 when there is no blockage of line of sight due to local terrain or obstacles when the on-channel power is set to the lower alarm limit, and within at least the following minimum coverage volume:

a. laterally:
   1. encompassing 360° around the VDB antenna,
   2. beginning at 100 m from the VDB antenna, and
   3. extending to 23 nm,

b. vertically, within the lateral region:
   1. within 3 nm of the VDB antenna, between the horizontal plane 12 ft above the ground at the antenna and a conical surface inclined at no less than 85° above the horizontal plane, up to a height of 10,000 ft and
   2. from 3 nm to 23 nm, between 10,000 ft AGL and a conical surface that is inclined at 0.9° above the horizontal plane with an origin 274 ft below the ground at the antenna.

3.1.1.2.2 Nominal Power

The LGF shall not exceed the maximum field strength requirements of Section 3.2.2.4 in any direction beginning at 200 m from the VDB antenna within the coverage volume specified in Section 3.1.1.2.1.

Figure 3-2 depicts a representation of the VDB coverage volume.

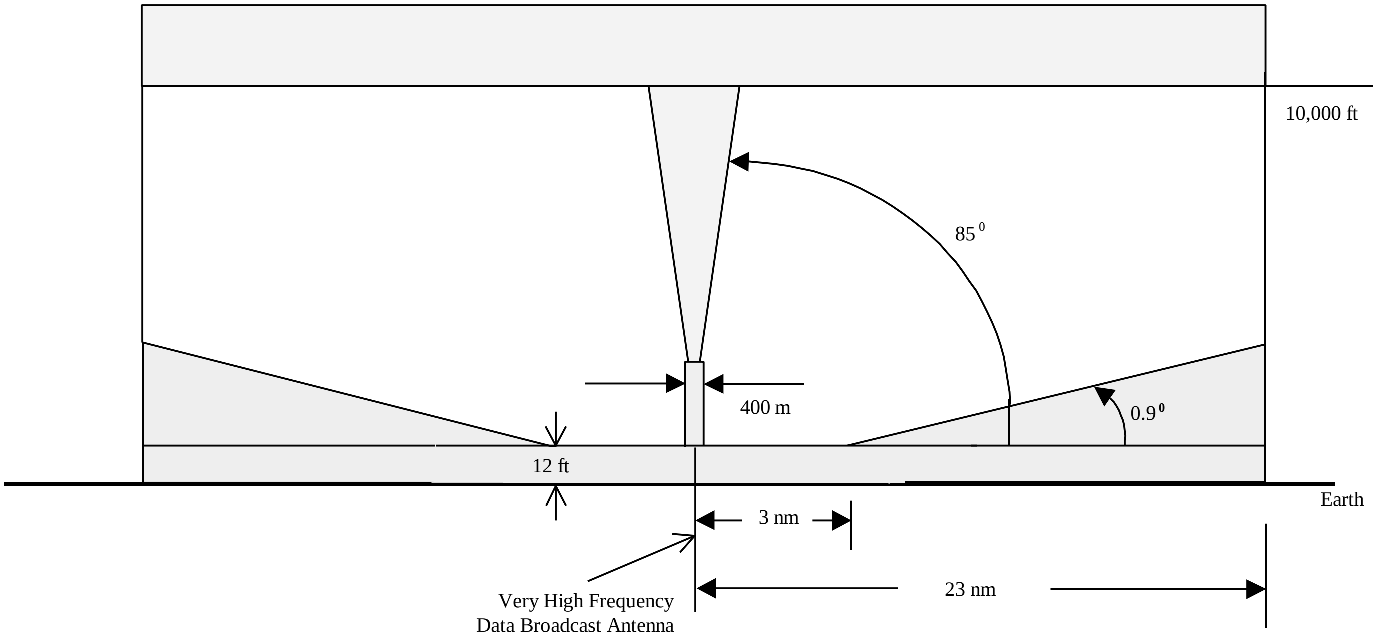

Figure 3-2. Local Area Augmentation System Ground Facility Coverage Volume

3.1.2 INTEGRITY

3.1.2.1 Integrity of Ranging Sources

The probability that the LGF transmits Misleading Information (MI) for 3 seconds or longer due to a ranging source failure shall not exceed 1.4×10^{-7} during any 150-second approach interval. This requirement has been allocated as shown in the Integrity Risk Allocation Tree (Appendix G) and to the requirements in

a. Section 3.2.1.2.7.3.1,

b. Section 3.2.1.2.7.3.2,

c. Section 3.2.1.2.7.3.3, and

d. Section 3.2.1.2.7.3.4.

3.1.2.2 Integrity of the Ground Facility

The probability that the LGF broadcasts erroneous data, or that one or more failures exist that affect the smoothed pseudorange corrections (pr_sca) from more than one Reference Receiver (RR) for 3 seconds or longer shall not exceed 1×10^{-8} (*editorial note: preliminary analysis indicates this number may change to* 0.4×10^{-8} *to meet position, velocity, and time information requirements for terminal area, which are specified over a 1 hour exposure time. This specification will more clearly spell out these requirements, but must be validated first*) in any

150-second interval. Erroneous data are data that do not mee the requirements in the following sections:

a. Section 3.2.1.2.1,
b. Section 3.2.1.2.7.1,
c. Section 3.2.1.2.7.5,
d. Section 3.2.1.2.7.6,
e. Section 3.2.1.2.7.7 (parent paragraph only),
f. Section 3.2.1.2.7.8,
g. Section 3.2.1.3.5,
h. Section 3.2.1.3.6,
i. Section 3.2.1.3.7,
j. Section 3.2.1.3.8,
k. Section 3.2.1.3.9,
l. Section 3.2.1.3.10,
m. 3.2.1.3.11, and
n. Section 3.2.1.4.

Note: Failure to satisfy the overbounding requirement of Section 3.2.1.2.7.7 due to an LGF failure or change in local environment (i.e., multipath) as described in Section 3.2.1.2.7.7.3 is included in the 10^{-8} per approach allocation. The performance of the LGF monitor, together with the underlying probability that such a condition exists, is included in the 10^{-8} per approach. Risk that s_{pr_gnd} does not meet the requirement in Section 3.2.1.2.7.7 under fault-free conditions (both system and local environment) and risk that the Refractivity Index, Scale Height, Refractivity Uncertainty, and s_{iono} bound spatial decorrelation errors are not included in the 10^{-8} per approach. These risks will be managed as part of the LGF qualification.

3.1.2.3 Integrity of a Single Reference Receiver

The probability that an undetected failure exists that affects any smoothed pseudorange, any predicted range, or any smoothed pseudorange correction from a single RR shall not exceed $1x10^{-5}$ in any 150-second interval.

3.1.2.4 Latent Failures

Compliance with requirements in Sections 3.1.2.1, 3.1.2.2, and 3.1.2.3 shall account for the probability that the associated monitors have failed.

3.1.3 CONTINUITY

3.1.3.1 VDB Transmission Continuity

The probability of an unscheduled interruption of the VDB transmission, where messages are not transmitted in accordance with Section 3.2.2 for a period equal to or greater than 3 seconds, shall not exceed $1x10^{-6}$ in any 15-second interval. On average, the LGF shall transmit at least 999 correctly formatted messages out of 1000 consecutive messages.

3.1.3.2 Reference Receiver and Ground Integrity Monitoring Continuity

The probability that the number of valid B-values is reduced for any valid ranging source within the reception mask shall not exceed $2.3x10^{-6}$ in any 15-second interval.

3.1.3.3 Latent Failures Affecting Continuity

If redundant equipment is used to meet the requirements in Sections 3.1.3.1 and 3.1.3.2, compliance shall account for the probability that the redundant equipment has failed.

3.1.4 STATES AND MODES

3.1.4.1 States

The LGF shall provide the following two states:

a. LGF On: Main or supplemental power is applied to the LGF equipment and

b. LGF Off: No power is applied to the LGF equipment.

Only one state shall exist at a time.

3.1.4.2 Modes

The LGF shall provide the following modes while in the On State:

a. Normal,

b. Not Available, and

c. Test.

There are no modes when the LGF is in the Off State.

Only one mode shall exist at a time. The LGF shall automatically transition from Normal to Not Available when there is an alarm condition.

3.1.4.3 Normal Mode

The LGF shall be in the Normal Mode when Test Mode has not been commanded and an alarm does not exist. The capability for the following conditions and actions to coexist within the Normal Mode shall include, but is not limited to:

a. Conditions:

   1. Alert (Section 3.1.5.1.2)

   2. Service Alert (Section 3.1.5.1.3)

   3. Constellation Alert (Section 3.1.5.1.4)

b. Actions:

   1. Approach Control (Sections 3.3.2.3.15 & 3.3.2.5.1)

   2. Periodic Maintenance (Section 3.3.1.6.3)

   3. Non-intrusive diagnostics (Section 3.3.2.3.19)

   4. LRU Replacement (Section 3.3.1.6.2.2)

   5. Data Recording (Section 3.3.3)

   6. Status monitoring (Sections 3.3.2.3.2, .3, .4, .7 - .9, .12, .14, .16, .18, & .20)

   7. User ID and password change (Section 3.3.1.7.2)

   8. Adjustment storage (Section 3.3.2.3.21)

   9. Fault recovery (Section 3.1.5.1.1)

c. Transition Criteria:

   1. Entering Normal Mode:

      a) Enter Normal Mode from Off State (power applied)

      b) Enter Normal Mode from Test Mode (Normal Mode commanded)

      c) Enter Normal Mode from Not Available Mode (Auto reset or Fault recovery commanded)

   2. Exiting Normal Mode:

      a) Exit Normal Mode to Not Available Mode (alarm)

      b) Exit Normal Mode to Test Mode (Test Mode commanded)

3.1.4.4 Not Available Mode

The LGF shall be in the Not Available Mode when an alarm exists and when it is not in Test Mode. The capability for the following conditions and actions to coexist within the Not Available Mode shall include, but is not limited to:

a. Condition:

   1. Alarm (Section 3.1.5.1.5)

b. Actions:

1. Automatic Restart (Section 3.1.5.1.5.1)
2. States and modes display (Section 3.1.4)
3. System power display (Section 3.3.2.3.7)
4. System events recording (Section 3.3.3.1)

c. Transition Criteria:

1. Entering Not Available Mode:
    a) Enter Not Available Mode from Normal Mode (alarm)
    b) Enter Not Available Mode from Test Mode
2. Exiting Not Available Mode:
    a) Exit Not Available Mode to Normal Mode (following auto restart or fault recovery)
    b) Exit Not Available Mode to Test Mode (Test Mode commanded)

3.1.4.5 Test Mode

Test Mode shall be defined as when the LGF is undergoing either maintenance or test. While in Test Mode, the VDB shall be capable of broadcasting all message types as if in the Normal or Not Available Mode. The LGF shall enter Test Mode when commanded by a maintenance specialist. The capability for the following conditions and actions to coexist within the Test Mode shall include, but is not limited to:

a. Conditions:

1. Alert (Section 3.1.5.1.2)
2. Service Alert (Section 3.1.5.1.3)
3. Constellation Alert (Section 3.1.5.1.4)
4. Alarm (Section 3.1.5.1.5)

b. Maintenance and test actions:

1. Restart the LGF (Section 3.3.2.3.1.1)
2. Intrusive and non-intrusive diagnostic control (Section 3.3.2.3.19)
3. Trouble shooting (Section 3.3.1.5)
4. Site specific parameter change (Sections 3.3.2.3.6 & 3.3.2.3.13)
5. Alert, service alert, constellation alert, and alarm threshold change (Section 3.3.2.3.10)
6. Redundant equipment status change (Section 3.3.2.3.17)
7. Monitor by-pass (Section 3.3.2.3.11)

8. VDB by-pass (Section 3.3.2.3.5)
9. Approach control (Section 3.3.2.3.15 & 3.3.2.5.1)
10. Periodic maintenance (Section 3.3.1.6.3)
11. LRU replacement (Section 3.3.1.6.2.2)
12. Data recording (Section 3.3.3)
13. Status monitoring (Sections. 3.3.2.3.2, .3, .4, .7 - .9, .12, .14, .16, .18, & .20)
14. User ID and password change (Section 3.3.1.7.2)
15. Adjustment storage (Section 3.3.2.3.21)
16. Fault recovery (Section 3.1.5.1.1)

c. Transition Criteria:

1. Entering Test Mode:
   a) Enter Test Mode from Normal Mode (Test Mode commanded)
   b) Enter Test Mode from Not Available Mode
2. Exiting Test Mode:
   a) Exit Test Mode to Normal Mode (Normal Mode commanded)
   b) Exit Test Mode to Not Available Mode

Upon exiting the Test Mode, the LGF shall revert to either the Normal or Not Available Mode, depending on the existence of an alarm.

The following figure, Figure 3-3, illustrates the allowable conditions and actions within LGF States and Modes.

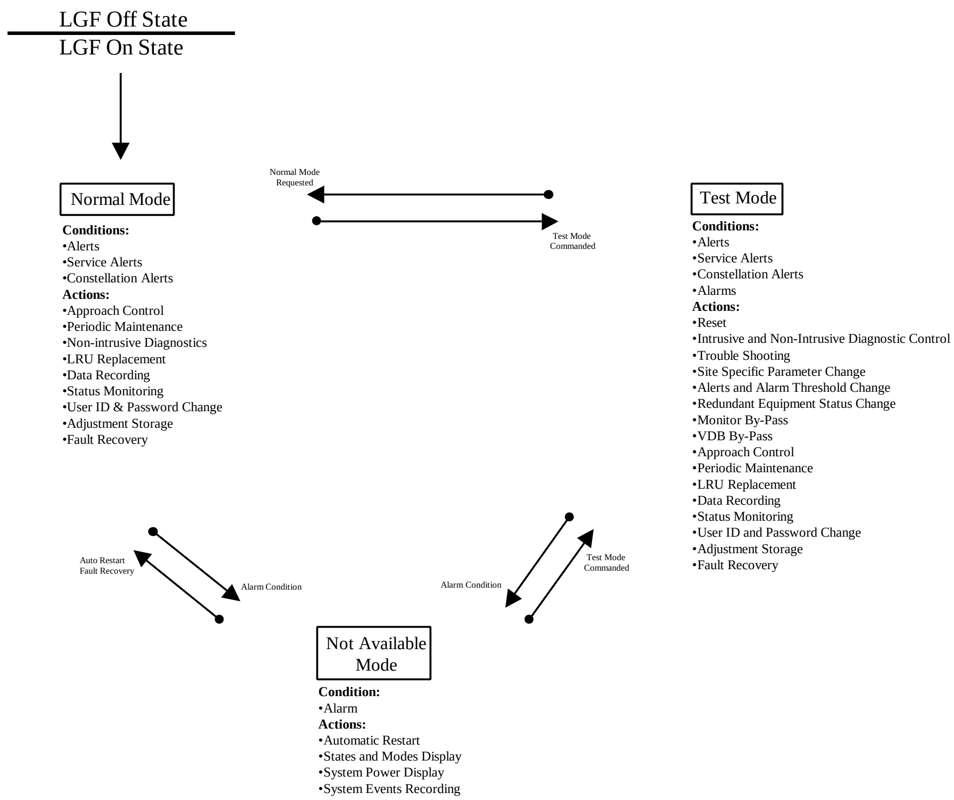

Figure 3-3. Local Area Augmentation System: States and Modes

3.1.5 EXECUTIVE MONITORING

3.1.5.1 Fault Monitoring

The LGF shall take the identified action for each fault condition identified in Table 3-1 and Table 3-2. Additional performance checks and system monitors may be required to meet the integrity requirements of Sections 3.1.2.2 and 3.1.2.3.

Table 3-1. Fault Conditions and Actions

Section	Fault	Action
Ranging Source		
3.2.1.2.7.3.1 (a)	Signal deformation	Exclude ranging source from Type 1 Message broadcast.
3.2.1.2.7.3.1 (b)/ 3.2.1.2.7.3.2 (a)	**Radio Frequency Interference**	Exclude PR_{mn}[1] from Pseudorange Correction (PRC) and B-value calculation, exclude ranging source from Type 1 Message broadcast, or exclude all measurements from RR from PRC and B-value calculation.
3.2.1.2.7.3.1 (c)/ 3.2.1.2.7.3.2 (b)	Ranging source signal level below threshold	Exclude ranging source from Type 1 Message broadcast.
3.2.1.2.7.3.1 (d)/ 3.2.1.2.7.3.2 (c)	Code and carrier divergence	Exclude ranging source from Type 1 Message broadcast.
3.2.1.2.7.3.1 (e)/ 3.2.1.2.7.3.2 (d)	Excessive acceleration, step, or other rapid changes on code or carrier	Exclude ranging source from Type 1 Message broadcast.
Corrections		
3.2.1.2.7.5.6.1 (a)	Filters not converged	Exclude PR_{mn}[1] from PRC and B-value calculation.
3.2.1.2.7.5.6.1 (b, c)	B-value exceeds limit	Exclude PR_{mn}[1] from PRC and B-value calculation.
3.2.1.2.7.5.6.1(d)	Pseudorange correction exceeds limit	Exclude ranging source from Type 1 Message broadcast.
3.2.1.2.7.6.1	Range rate Correction (RRC) exceeds limit	Exclude ranging source from Type 1 Message broadcast.
3.2.1.2.7.6.1.1	Faulted σ_{rrc}	Exclude PR_{mn}[1] from PRC and B-value calculation, exclude ranging source from Type 1 Message broadcast, or exclude all measurements from RR from PRC and B-value calculation.
3.2.1.2.7.7.3	Faulted σ_{pr_gnd}	Exclude PR_{mn}[1] from PRC and B-value calculation, exclude ranging source from Type 1 Message broadcast, or exclude all measurements from RR from PRC and B-value calculation.
Data Broadcast		
3.2.3 (a)	Disagreement between transmitted data	Terminate VDB output.
3.2.3 (b)	On-channel assigned power exceeds limits	Terminate VDB output.
3.2.3 (c)	0.2% of messages not transmitted in last hour	Terminate VDB output.
3.2.3 (d)	No transmission for 3 seconds	Terminate VDB output.
3.2.3 (e)	Transmitted data outside of assigned Time Division Multiple Access (TDMA) time slots	Terminate VDB output.

[1] *Pseudorange (PR), where m indicates an individual RR and n indicates an individual ranging source.*

Table 3-2. Valid GPS and SBAS Navigation Data

Section	Fault	Action
3.2.1.2.7.3.3:		
(a)	Failed parity	Exclude GPS ranging source from Type 1 Message broadcast
(b)	Bad IODC	Exclude GPS ranging source from Type 1 Message broadcast
(c)	HOW bit 18 set to “1”	Exclude GPS ranging source from Type 1 Message broadcast
(d)	Data bits in subframes 1, 2, or 3 set to “0”	Exclude GPS ranging source from Type 1 Message broadcast
(e)	Subframes 1, 2, or 3 set to default	Exclude GPS ranging source from Type 1 Message broadcast
(f)	Preamble incorrect	Exclude GPS ranging source from Type 1 Message broadcast
(g)	Navigation data inconsistent between RRs	Exclude GPS ranging source from Type 1 Message broadcast
(h)	Almanac differs from ephemeris by more than 7000 m at any point	Exclude GPS ranging source from Type 1 Message broadcast
(i)	After valid corrections computed, PRC or PRC rate exceeds limit	Exclude GPS ranging source from Type 1 Message broadcast
(j)	Receive “Do Not Use” SBAS message	Exclude GPS ranging source from Type 1 Message broadcast
(k)	Ephemeris CRC changes and IODE does not	Exclude GPS ranging source from Type 1 Message broadcast
(l)	GPS PRN = 37	Exclude GPS ranging source from Type 1 Message broadcast
(m)	Satellite declared unhealthy	Exclude GPS ranging source from Type 1 Message broadcast
	Ephemeris not consistent to within 250 m	Exclude GPS ranging source from Type 1 Message broadcast
3.2.1.2.7.3.4:		
(a)	Failed parity	Exclude SBAS ranging source from Type 1 Message broadcast
(b)	Navigation data inconsistent between RRs	Exclude SBAS ranging source from Type 1 Message broadcast
(c)	Almanac differs from ephemeris by more than 200 km at any point	Exclude SBAS ranging source from Type 1 Message broadcast
(d)	SBAS positions changes more than 0.12 m in 4 minutes	Exclude SBAS ranging source from Type 1 Message broadcast
(e)	No SBAS navigation message for 4 minutes	Exclude SBAS ranging source from Type 1 Message broadcast
(f)	After valid corrections computed, PRC or PRC rate exceeds limit	Exclude SBAS ranging source from Type 1 Message broadcast
(g)	Receive ‘Do Not Use” SBAS message	Exclude SBAS ranging source from Type 1 Message broadcast

3.1.5.1.1 Fault Recovery

Upon exclusion of a single measurement, ranging source, or RR the LGF shall continue to monitor the excluded single measurement, ranging source, or RR. For ranging source faults and correction faults in Table 3-1, except as noted in Section 3.2.1.2.7.7.3, the LGF shall re-introduce the excluded single measurement, ranging source, or RR when the fault no longer exists. After detecting a ranging source fault, the probability of re-introducing the excluded single measurement, ranging source, or RR when the fault condition persists shall be less than 1.94×10^{-9}.

3.1.5.1.2 Generation of Alerts

The LGF shall generate an alert upon detecting a fault that does not affect the ability of the system to meet the integrity requirements of Section 3.1.2. Faults shall include the ranging source and correction faults identified in Table 3-1, navigation data in Table 3-2, and environmental sensor conditions exceeding the limits defined in Sections 3.3.1.4.3, 3.3.1.4.4, 3.3.1.4.5, and 3.3.1.4.6. Alert thresholds shall be defined during the design process.

3.1.5.1.3 Generation of Service Alerts

A service alert is defined as a fault that could affect LGF service and requires corrective maintenance. Service alert thresholds shall be defined during the design process.

3.1.5.1.3.1 Continuity Faults

A service alert shall be generated when the LGF is unable to insure that the continuity requirements of Section 3.1.3 can be met due to a fault in any of the following items:

a. main and standby Line Replaceable Units (LRU)s,

b. hardware components,

c. internal firmware, and

d. uninterruptible power supply.

3.1.5.1.3.2 Environmental Faults

A service alert shall be generated when the thresholds for the following environmental sensors are exceeded:

a. intrusion detector (Section 3.3.1.4.1),

b. smoke detector (Section 3.3.1.4.2),

c. Alternating Current (AC) power (Section 3.3.1.4.4), and

d. inside temperature (Section 3.3.1.4.5).

3.1.5.1.4 Generation of Constellation Alerts

A constellation alert shall be generated 20 minutes ± 1 minute before a loss of service availability. Only losses of service predicted to be longer than 1 minute shall cause a constellation alert. Constellation alerts shall be based on aircraft equipage with Aircraft Accuracy Designator B LAAS avionics. The probability that an ATCU provides a constellation alert while service is available shall be less than $1x10^{-2}$. The probability that an ATCU is not provided with a constellation alert while service is not available shall be less than $1x10^{-2}$.

3.1.5.1.5 Generation of Alarms

The LGF shall generate an alarm when the integrity requirements of Section 3.1.2 cannot be guaranteed. The LGF shall generate an alarm when the VDB monitor has detected any fault identified in Section 3.2.3. When an alarm is generated, one of the following actions is taken:

a. When the requirements of Section 3.1.2.1 cannot be met, the LGF shall broadcast the Type 1 Message with no measurement blocks.

b. When the requirements of Section 3.1.2.2 cannot be met, the LGF shall terminate the VDB output.

c. When there is a fault detected in accordance with the requirements of Section 3.2.3, the LGF shall terminate the VDB output.

Alarm thresholds shall be defined during the design process.

3.1.5.1.5.1 Automatic Restart

The LGF shall attempt an automatic restart (Section 3.3.2.3.1.1) within 3 minutes following an alarm. If an alarm condition still exists following the restart attempt, restart shall be available only through manual command via the MDT.

3.1.6 SOFTWARE DESIGN ASSURANCE

All LGF software functions shall be compliant with the guidelines and objectives of the applicable software level specified in “Software Considerations in Airborne Systems and Equipment Certification” (RTCA/DO-178B, 1993).

All software for the LGF shall be Year 2000 (Y2K) compliant. All software for the LGF shall accommodate any date between December 31, 1999 and December 31, 2049.

3.1.7 COMPLEX ELECTRONIC HARDWARE DESIGN ASSURANCE

Complex electronic hardware devices including, but not limited to, Application Specific Integrated Circuits (ASICs) and Programmable Logic Devices (PLDs), shall be produced with structured development, verification, configuration management, and quality assurance processes.

The level of production process rigor associated with complex electronic hardware shall be based on the contribution of the hardware to potential failure conditions as determined by the System Safety Assessment (SSA) process.

All hardware for the LGF shall be Y2K compliant. All hardware for the LGF shall accommodate any date between December 31, 1999 and December 31, 2049.

3.2 DATA BROADCAST

3.2.1 BROADCAST DATA REQUIREMENTS

All message types shall be in accordance with Section 2.4.1 of RTCA/DO-246A. The data format shall be in accordance with Section 2.4.2 of RTCA/DO-246A, except as noted in Appendix H.

All static parameters to be broadcast and default values shall be stored in the LGF Non-Volatile Memory (NVM). NVM storage shall be a minimum of 90 days without power applied.

3.2.1.1 LAAS Message Block

The LGF shall transmit the LAAS message block. The LAAS message block consists of the Message Block Header, the Message, and the Cyclic Redundancy Check (CRC).

3.2.1.1.1 Message Block Header

3.2.1.1.1.1 Message Block Identifier

The LGF shall set the Message Block Identifier Field to 1010 1010 when the LGF is not in Test Mode.

The LGF shall set the Message Block Identifier Field to 1111 1111 when the LGF is in Test Mode.

3.2.1.1.1.2 Ground Station Identification

The GBAS ID Field shall denote the LGF station Identification (ID) stored in LGF NVM.

3.2.1.1.1.3 Message Type Identifier

The Message Type Identifier Field shall only denote Message Type 1, 2, or 4.

3.2.1.1.1.4 Message Length

The Message Length Field shall denote the number of 8-bit words in the message block. The message length includes the header, the message, and the CRC field.

3.2.1.1.2 Message

The LGF shall transmit Message Types 1, 2, and 4.

3.2.1.1.3 Cyclic Redundancy Check

The CRC Field shall denote the CRC calculated on the message header and the message.

3.2.1.2 Type 1 Message – Differential Corrections

The LGF shall broadcast the Type 1 Message a minimum of once per frame. The LGF shall broadcast the Type 1 Message a maximum of once per slot per frame. If more than two slots are assigned so that the Type 1 Message is repeated within a frame, the modified Z-count shall not change and the measurement block shall contain the same data.

The LGF shall broadcast the Type 1 Message formatted in accordance with Section 2.4.3 of RTCA/DO-246A, except as noted in Appendix H. The LGF shall provide the capability to generate the ranging source measurement block for 18 ranging sources. Broadcast of the Type 1 Message shall occur no later than 0.5 seconds after the time indicated by the Modified Z-count, corresponding to the corrections.

Note: All measurement types are of Type 0 as defined in RTCA/DO-246A.

3.2.1.2.1 Modified Z-Count

The Modified Z-count Field shall denote the reference time for all the message parameters in the Type 1 Message. The Modified Z-count for Type 1 Messages of a given measurement type shall advance every frame.

3.2.1.2.2 Additional Message Flag

The Additional Message Flag Field shall denote that additional messages are not provided.

3.2.1.2.3 Number of Measurements

The Number of Measurements Field shall denote the number of ranging source measurement blocks broadcast in the Type 1 Message.

3.2.1.2.4 Measurement Type

The Measurement Type Field shall denote the measurement type is GPS L1 C/A code.

3.2.1.2.5 Ephemeris CRC

The Ephemeris CRC Field shall apply the CRC computed for the ranging source associated with the first ranging source measurement block in the Type 1 Message.

3.2.1.2.6 Source Availability Duration

The Source Availability Duration Field shall denote the period that the ranging source will remain within the reception mask associated with the first ranging source measurement block relative to the Modified Z-count.

3.2.1.2.6.1 Reception Mask

The reception mask for the LGF shall define the region where corrections from ranging source signals are broadcast. The nominal mask shall include all elevations from 5° to 90° and all azimuths from 0° to 360°, excluding the blockage effects of any obstacle protruding from the horizontal plane.

3.2.1.2.7 Ranging Source Measurement Block

The first ranging source in the message shall sequence so that the ephemeris CRC and source availability duration for each ranging source is transmitted at least once every 10 seconds, except when new ephemeris data are received from a ranging source. When new ephemeris data are received from a ranging source, the LGF shall broadcast the new ephemeris data for that ranging source in three consecutive Type 1 Messages. When new ephemeris data are received from more than one ranging source, the first ranging source in the Type 1 Message shall sequence so that the ephemeris CRC and source availability duration for each ranging source are transmitted at least once every 27 seconds.

3.2.1.2.7.1 Ranging Source Identification

The Ranging Source ID Field shall denote the satellite pseudorandom number assigned to the ranging source associated with the ranging source measurement block.

3.2.1.2.7.2 Ranging Signal Sources

The LGF shall be capable of processing

a. GPS SPS signals, as defined in the GPS SPS Signal Specification and

b. SBAS signals, as defined in the Wide Area Augmentation System (WAAS) Specification (FAA-E-2892B).

3.2.1.2.7.3 Conditions for Transmitting the Ranging Source Measurement Block

3.2.1.2.7.3.1 Valid GPS Ranging Sources

The LGF shall detect ranging source failures, a – e, that cause a pseudorange correction error exceeding the values in Table 3-3 for all allowable airborne configurations defined in Appendix E. The probability of missed detection for each failure, a – e, shall be $\leq 1\text{x}10^{-3}$. The LGF shall cease broadcast of a failed ranging source measurement block within 3 seconds of the onset of the failure. Prior to broadcast of pseudorange corrections for a ranging source when it enters the reception mask, the LGF shall detect each failure, a – e, with a missed detection probability of $\leq 1.1\text{x}10^{-4}$:

a. The ranging source is distorted by any of the following:

1. Each falling edge of the positive chips in the C/A code is delayed by Δ seconds, where $0 \leq \Delta \leq 120$ nanoseconds.

2. Each falling edge of the positive chips in the C/A code is advanced by Δ seconds, where $0 \leq \Delta \leq 120$ nanoseconds.

3. The distorted C/A code is the output of a second order linear system that has the standard C/A code as an input. The system is characterized by a damping factor, σ, and a resonant frequency, f_d, as shown:

$$\xrightarrow{\text{C/A Code}} \boxed{\frac{(2\pi f_0)^2}{s^2+2\sigma s+(2\pi f_0)^2}} \xrightarrow{\text{Distorted C/A Code}} \qquad (1)$$

where $f_0 = \frac{1}{2\pi}\sqrt{\sigma^2+(2\pi f_d)^2}$ and (2)

s is the complex frequency used in Laplace transforms.

Each step, e_0, in the input C/A sequence results in a second order step response that is given by

$$e(t) = e_0\left\{1-\exp(-\sigma t)\left[\cos 2\pi f_d t + \frac{\sigma}{2\pi f_d}\sin 2\pi f_d t\right]\right\}, \qquad (3)$$

for this waveform,

$0.8\text{x}10^6 \leq \sigma \leq 8.8\text{x}10^6$ nepers/second
$4\text{x}10^6 \leq f_d \leq 17\text{x}10^6$ cycles/second.

4. The distorted C/A code is the output of a second order linear system characterized by a damping factor and a resonant frequency with an input of a modified standard C/A code, where every falling edge of the positive chip in the modified C/A code is

a) delayed by Δ seconds, where $0 \leq \Delta \leq 120$ nanoseconds

b) advanced by Δ seconds, where $0 \leq \Delta \leq 120$ nanoseconds

$$\xrightarrow{\text{C/A Code}} \boxed{\text{Falling edge lead/lag } \Delta} \xrightarrow{\text{Modified C/A Code}} \boxed{\frac{(2\pi f_0)^2}{s^2+2\sigma s+(2\pi f_0)^2}} \xrightarrow{\text{Distorted C/A Code}} \qquad (4)$$

This waveform has the combined effects of items 1, 2, and 3, but the damping factor and resonant frequency are varied over a smaller range, specifically:

$$0.8\text{x}10^6 \leq \sigma \leq 8.8\text{x}10^6 \text{ nepers/second}$$
$$7.3\text{x}10^6 \leq f_d \leq 13\text{x}10^6 \text{ cycles/second.}$$

b. Radio Frequency (RF) Interference (RFI) in excess of levels defined in Appendix A;

c. Signal levels below those specified in Section 2.3.4 of the GPS SPS Signal Specification;

d. Code and carrier divergence; and

e. Excessive acceleration, such as step or other rapid changes, of the code and carrier phases on the differential correction process.

Table 3-3. Error Values – Global Positioning System

Failure Condition	Value
a	$5.8\ s_{pr\_gnd,n}$
b	$\frac{4.9}{\sqrt{N'}} s_{pr\_gnd,n}$ (5)
c, d, and e	$4.9\ s_{pr\_gnd,n}$

where $s_{pr\_gnd,n}$ is for the n[th] ranging source, as defined in Section 3.2.1.2.7.7,

n is the ranging source index, and

N' has two values:
N' is equal to 1 when there is interference on zero or one ranging source and
N' is equal to the number of ranging sources in the last broadcast Type 1 Message when there is interference on two or more ranging sources.

3.2.1.2.7.3.2 Valid SBAS Ranging Sources

The LGF shall detect ranging source failures, a – d, that cause a pseudorange correction error exceeding the values in Table 3-4. The probability of missed detection shall be $\leq 1\text{x}10^{-3}$. The LGF shall cease broadcast of a failed ranging source measurement block within 3 seconds of the onset of the failure. Prior to broadcast of pseudorange corrections for a ranging source when it enters the reception mask, the LGF shall detect failures, a – d, with a missed detection probability of $\leq 1.1\text{x}10^{-4}$.

a. RFI in excess of levels defined in Appendix A;

b. Signal levels below those specified in Appendix 2, Section 2.6.5 of FAA-E-2892B;

c. Code and carrier divergence; and

d. The impact of excessive acceleration, such as step or other rapid changes, of the code and carrier phases on the differential correction process.

Table 3-4. Error Values – Space Based Augmentation System

Failure Condition	Value
a	$\frac{4.9}{\sqrt{N'}} s_{pr\_gnd,n}$ (6)
b, c, d	$4.9\ s_{pr\_gnd,n}$

3.2.1.2.7.3.3 Valid GPS Navigation Data

The LGF shall not broadcast the ranging source measurement block if

a. three or more parity errors have been detected in the previous 6 seconds, in accordance with the parity algorithm equations defined in Section 2.5.2 of the GPS SPS Signal Specification;

b. broadcast Issue of Data (IOD) Ephemeris (IODE) does not match eight least-significant bits of broadcast IOD Clock (IODC);

c. bit 18 of the Hand-over-Word (HOW) is set to 1 (Section 2.4.2.2 of the GPS SPS Signal Specification);

d. all data bits are zeros in subframes 1, 2, or 3;

e. default navigation data are being transmitted in subframes 1, 2, or 3 for that satellite (Section 2.4.1.3 of the GPS SPS Signal Specification);

f. the preamble does not equal 8B (hexadecimal);

g. the same ephemeris and clock data were not used by all RRs to compute the PRC;

h. any point on the orbit defined by the broadcast ephemeris is more than 7000 m from the orbit defined by the broadcast almanac;

i. after valid corrections were computed by the LGF, the pseudorange correction bound (Section 3.2.1.2.7.5.6.1 [d]) or the RRC bound (Section 3.2.1.2.7.6.1) was exceeded at any time using the broadcast ephemeris data;

j. an SBAS within the reception mask broadcasts a Message Type 2, 3, 4, 5, 6, or 24 indicating "Do Not Use This GPS Satellite" as defined in Section 2.1.1.4 of RTCA/DO-229A;

k. the ephemeris CRC changes and the IODE does not;

l. the decoded GPS PRN is 37; or

m. the health bits in subframe 1 word 3 indicate that the satellite is unhealthy.

A new ephemeris shall be compared to the previously broadcast ephemeris, if available, and is validated if the difference in satellite position is less than 250 m and none of the conditions a – m exists. Ephemerides shall be validated and applied within 3 minutes of receiving a new set, but not before they have been continuously present for 2 minutes.

3.2.1.2.7.3.4 Valid SBAS Navigation Data

The LGF shall not broadcast the ranging source measurement block if

a. three or more parity errors have been detected in the previous 6 seconds, in accordance with the parity algorithm equations defined in Appendix 2, Section 4.3.3 of FAA-E-2892B;

b. the same ephemeris and clock data were not used by all RRs to compute the PRC;

c. the satellite position defined by the broadcast ephemeris is more than 200 km from the satellite position defined by the broadcast almanac;

d. the differences between satellite positions defined by any of the SBAS navigation messages broadcast in the previous 4 minutes is greater than 0.12 m;

e. more than 4 minutes have elapsed since reception of the SBAS navigation message;

f. after valid corrections were computed by the LGF, the pseudorange correction bound (Section 3.2.1.2.7.5.6.1 [d]) or the RRC bound (Section 3.2.1.2.7.6.1) was exceeded at any time using the broadcast ephemeris data; or

g. the SBAS satellite for which the ranging source measuerment block provides a correction broadcasts a Message Type 0 indicating "Do Not Use This SBAS Signal", a Message Type 2, 3, 4, 5, 6, or 24 indicating "Do Not Use This SBAS Satellite", or if its health and status bits in Message 17 indicate "Ranging off", as defined in Section 2.1.1.4 of RTCA/DO-229A.

After confirming that none of the conditions a – g exists, new SBAS navigation data shall be used for subsequent measurements.

3.2.1.2.7.4 Issue of Data

The IOD Field shall denote the IODE for GPS or IOD for SBAS associated with the ephemeris data used to determine the broadcast correction.

3.2.1.2.7.5 Pseudorange Corrections

The Pseudorange Correction Field shall denote the broadcast pseudorange correction.

3.2.1.2.7.5.1 Smoothed Pseudorange

In steady state, each pseudorange measurement from each RR shall be smoothed using the filter

$$PR_s(k) = \left(\frac{1}{N}\right) PR_r(k) + \left(\frac{N-1}{N}\right) \left[PR_s(k-1) + f(k) - f(k-1)\right] \tag{7}$$

$$N = S / T$$

where PR_r is the raw pseudorange,

PR_s is the smoothed pseudorange,

N is the number of samples,

S is the time filter constant, equal to 100 seconds,

T is the filter sample interval, nominally equal to 0.5 seconds and not to exceed 1 second,

ϕ is the accumulated phase measurement,

k is the current measurement, and

k-1 is the previous measurement.

The raw pseudorange shall be determined under the following conditions:

a. Correlator spacing between the early and the late correlators are 0.1 chip width $\pm$ 0.02.

b. The code loop is carrier driven and of first order, or higher, and has a one-sided noise bandwidth $\geq$ 0.125 Hz.

c. The strongest correlation peak is acquired taking into account the effect of any secondary peak found at any code offset within the entire code sequence.

3.2.1.2.7.5.2 GPS Predicted Range

The predicted range to each GPS ranging source shall be computed from the corresponding RR antenna phase center location and the validated ephemeris. The ephemeris shall be determined in accordance with Section 2.5.4 of the GPS SPS Signal Specification.

3.2.1.2.7.5.3 SBAS Predicted Range

The predicted range to each SBAS ranging source shall be computed from the corresponding RR antenna phase center location and the validated ephemeris. The position of the ranging source shall be determined in accordance with Appendix 2, Section 4.4.11 of FAA-E-2892B.

3.2.1.2.7.5.4 GPS Smoothed Pseudorange Correction

The smoothed pseudorange correction (PR_{sc}) for a GPS ranging source shall be calculated using the equation

$$PR_{sc} = R - PR_s - t_{sv\_gps} \quad (8)$$

where R is the predicted range and

t_{sv_gps} is the correction due to the satellite clock from the decoded GPS Navigation Data in accordance with the algorithms given in Sections 2.5.5.1 and 2.5.5.2 of the GPS SPS Signal Specification.

Ionospheric and tropospheric corrections shall not be applied to the smoothed pseudorange correction.

3.2.1.2.7.5.5 SBAS Smoothed Pseudorange Correction

The smoothed pseudorange correction (PR_{sc}) for an SBAS ranging source shall be calculated using the equation

$$PR_{sc} = R - PR_s - t_{sv\_sbas} \tag{9}$$

where t_{sv_sbas} is the correction due to the satellite clock from the decoded WAAS Navigation Data Message Type 9 in accordance with the algorithm given in Appendix 2, Section 4.4.11 of FAA-E-2892B.

3.2.1.2.7.5.6 Broadcast Correction

The broadcast correction shall be calculated using the equations

$$PR_{corr}(n) \equiv \frac{1}{M(n)} \sum_{m \in S_n} PR_{sca}(n,m) \text{ and} \tag{10}$$

$$PR_{sca}(n,m) \equiv PR_{sc}(n,m) - \frac{1}{N_c} \sum_{n \in S_c} PR_{sc}(n,m). \tag{11}$$

where PR_{corr} is the broadcast correction;

$M(n)$ is the number of elements in set S_n;

PR_{sca} is the carrier smoothed and receiver clock adjusted pseudorange correction;

n is the satellite index;

S_n is the set of RRs with valid measurements for satellite n;

m is the RR index;

S_c is the set of valid ranging sources tracked by all RRs; and

N_c is the number of elements in set S_c;

given the following conditions:

a. if N_c is less than four, no corrections shall be provided in the Type 1 Message,

b. M shall be at least three for the fault free configuration,

c. each RR measurement (*m,n*) used to determine the broadcast corrections shall be updated at no less than a 2 Hz rate, and

d. each RR measurement (*m,n*) used to determine the broadcast corrections shall be based on identical signal processing techniques and tracking loop characteristics.

3.2.1.2.7.5.6.1 Correction Errors

The LGF shall broadcast the ranging source measurement block when

a. more than 200 seconds have expired since smoothing filter initialization, or s_{pr_gnd} for the ranging source accounts for the smoothing filter output error relative to steady-state induced by a code-minus carrier divergence of 0.01 m/s;

b. the magnitude of the associated B-values does not exceed $\frac{5.6 s_{pr\_gnd}}{\sqrt{M(n)-1}}$ (12)

for GPS ranging sources;

c. the magnitude of the associated B-values does not exceed $\frac{5.6\left(s_{pr\_gnd}\right)}{\sqrt{M(n)-1}}$ (13)

for SBAS ranging sources (equation 17); and

d. the magnitude of the pseudorange correction does not exceed 327.67 m.

3.2.1.2.7.6 Range Rate Correction

The Range Rate Correction Field shall indicate the rate of change of the pseudorange correction, defined to be RRC_{corr}, based on the current and immediately prior broadcast corrections. The current and immediately prior broadcast corrections shall compensate for changes in S_c and ephemeris changes to eliminate rate spikes.

3.2.1.2.7.6.1 Condition for Valid Range Rate Correction

The LGF shall not broadcast the ranging source measurement block if

a. the RRC exceeds ±3.4 m per second or

b. the standard deviation of the error in the RRC exceeds 4.0 cm per second.

3.2.1.2.7.6.1.1 Range Rate Correction Monitor

The LGF shall not broadcast the ranging source measurement block if

$$B_{RRC} > 5.6 s_{rrc}\left(\sqrt{M(n)-1}\right)^{-1} \quad (14)$$

where $B_{RRC}(n,m) = RRC_{corr}(n) - \frac{1}{M(n)-1}\sum_{\substack{i\in S_n \\ i\notin m}} RRC_{sca}(n,i)$, given that (15)

RRC_{sca} is the carrier smoothed and receiver clock adjusted range rate correction for an individual receiver that is compensated for changes in S_c and ephemeris and

σ_{rrc} is the one sigma range rate correction error that is established at installation.

3.2.1.2.7.7 Sigma Pseudorange Ground

The σ_{pr_gnd} shall be broadcast for each ranging source so that

a. the Vertical Protection Limit $(VPL)_{H0}$ and Lateral Protection Limit $(LPL)_{H0}$ bound the user position error with an integrity risk not greater than those indicated in Table 3-5 for a user located at the LGF reference point, given that the LGF is fault free and the local multipath environment is consistent with that described in the installation guidelines and

b. the VPL_{H1} and LPL_{H1} bound the user position error with an integrity risk not greater than those indicated in Table 3-5 for a user located at the LGF reference point, given that an undetected failure from a RR exists that affects the smoothed pseudorange corrections (PR_{sca}) , where

1. $VPL_{H0,}$ $LPL_{H0,}$ $VPL_{H1,}$ and LPL_{H1} are computed in accordance with Section 3.1.3.4.6 of RTCA/DO-245 *(editorial note: these equation do not include the sigma iono term and will be updated when revised MOPS is complete)*;

2. the user position is calculated in accordance with Section 3.1.3.4.5 of RTCA/DO-245 using any combination of four or more ranging sources; and

3. and the airborne contribution to the corrected pseudorange error is assumed to be zero.

Table 3-5. Sigma Pseudorange Ground Detection Probabilities

Integrity Risk (probability)	Maximum Number of Reference Receivers used to Formulate the Broadcast Pseudorange Corrections used in the Associated Position Solution		
	2	3	4
a. Fault free missed detection	8.33×10^{-9}	6.25×10^{-9}	5.01×10^{-9}
b. Missed detection	1.67×10^{-3}	1.88×10^{-3}	2.00×10^{-3}

3.2.1.2.7.7.1 GPS Sigma Pseudorange Accuracy

Under the minimum signal strength defined in Section 2.3.4 of the GPS SPS Signal Specification and the standard interference environment defined in Appendix A, the accuracy of the LGF shall be such that

$$\sigma_{pr\_gnd}(\theta_n) \le \sqrt{\frac{\left(a_0 + a_1 e^{-\theta_n/\theta_0}\right)^2}{M} + (a_2)^2} \qquad (16)$$

where θ_n is the n[th] ranging source elevation angle,

a_0, a_1, a_2, and θ_0 are the coefficients for the applicable Accuracy Designator defined in Table 3-6, and

M is the number of corrections per ranging source.

Table 3-6. GPS Accuracy Designator C Coefficients

Accuracy Designator C	a_0 meters	a_1 meters	a_2 meters	θ_0 degrees
$\theta_n \geq 35°$	0.15	0.84	0.04	15.5
$\theta_n < 35°$	0.24	0	0.04	-

The accuracy requirement shall be met within the reception mask given in Section 3.2.1.2.6.1.

3.2.1.2.7.7.2 SBAS Sigma Pseudorange Accuracy

Under the minimum signal strength defined in Appendix 2, Section 2.6.5 of FAA-E-2892B and the standard interference environment defined in Appendix A, the accuracy of the LGF shall be such that

$$\sigma_{pr\_gnd} \le \frac{1.8}{\sqrt{M}} \qquad (17)$$

The accuracy requirement shall be met within the reception mask given in Section 3.2.1.2.6.1.

3.2.1.2.7.7.3 Condition for Valid Sigma Pseudorange Ground

The LGF shall detect conditions that result in noncompliance with conditions ‘a’ and ‘b’ in Section 3.2.1.2.7.7. If the increase in system risk associated with degraded performance is minimal, but exceeds design tolerances, the LGF shall initiate a service alert. The probability of a false service alert shall be adjustable, but set to achieve a nominal false alert rate of 10^{-4} per hour. If the increase in system risk is not minimal, the LGF shall exclude the offending RR or generate an alarm, as appropriate. A service alert shall be issued when a RR is excluded. Self-recovery shall not be applied in either case. Automatic restart shall not be attempted when an alarm condition exists when system risk is not minimal. The probability of false RR exclusion or alarm shall equal 10^{-7} per 15-second interval. In detecting these conditions, LGF performance over the previous one hour, one day, one month, and since initialization shall be used. Monitored parameters shall include the distribution of B-values and correlation between RRs.

3.2.1.2.7.8 B-Values

The B-Value Field shall denote the B-value calculated using the equation

$$B_{PR}(n,m) \equiv PR_{corr}(n) - \frac{1}{M(n)-1} \sum_{\substack{i \in S_n \\ i \neq m}} PR_{sca}(n,i) \tag{18}$$

where $B_{PR}(n,m)$ is the estimate of the error contribution to the average correction from RR m.

3.2.1.3 Type 2 Message – Differential Reference Point

The LGF shall broadcast the Type 2 Message at least once every 20 consecutive frames. The LGF shall broadcast the Type 2 Message a maximum of once per frame. The LGF shall broadcast the Type 2 Message formatted in accordance with Section 2.4.4 of RTCA/DO-246A, except as noted in Appendix H.

3.2.1.3.1 Ground Station Installed Receivers

The Ground Station Installed Receivers Field shall denote the number of installed reference receivers stored in LGF NVM.

3.2.1.3.2 Ground Station Accuracy Designator

The Ground Station Accuracy Designator Field shall denote the accuracy designator stored in LGF NVM.

3.2.1.3.3 Continuity and Integrity Designator

The LGF Ground Continuity and Integrity Designator (GCID) Field shall denote the LGF GCID. The LGF GCID shall be 001 when no alarm exists. The LGF GCID shall be 111 when an alarm exists.

3.2.1.3.4 Local Magnetic Variation

The Local Magnetic Variation Field shall denote the local magnetic variation stored in LGF NVM.

3.2.1.3.5 Refractivity Index

The Refractivity Index Field shall denote the refractivity index stored in LGF NVM.

3.2.1.3.6 Scale Height

The Scale Height Field shall denote the scale height stored in LGF NVM.

3.2.1.3.7 Refractivity Uncertainty

The Refractivity Uncertainty Field shall denote the refractivity uncertainty stored in LGF NVM.

3.2.1.3.8 Latitude

The Latitude Field shall denote the LGF reference point latitude stored in LGF NVM.

The LGF reference point shall be defined as the coordinates of a single RR antenna location for each installation.

3.2.1.3.9 Longitude

The Longitude Field shall denote the LGF reference point longitude stored in LGF NVM.

3.2.1.3.10 Reference Point Height

The Reference Point Height Field shall denote the LGF reference point height above the WGS-84 ellipsoid stored in LGF NVM.

3.2.1.3.11 Sigma Ionosphere

The Sigma Ionosphere Vertical Gradient Field shall denote the sigma ionosphere value stored in LGF NVM.

3.2.1.4 Type 4 Message – Final Approach Segment Data

The Type 4 Message shall include the Data Set Length, Final Approach Segment (FAS) Data Block, the FAS/Vertical Alert Limit (VAL) approach status, and the FAS/Lateral Alter Limit (LAL) approach status. The LGF shall broadcast each FAS data block at least once every 20 consecutive frames. The LGF shall broadcast each FAS data block a maximum of once per frame. The LGF shall broadcast the Type 4 Message formatted in accordance with Section 2.4.6 of RTCA/DO-246A, except as noted in Appendix H..

3.2.1.4.1 Data Set Length

The Data Set Length Field shall denote the Type 4 Message data set length, which indicates the number of bytes in the data set.

3.2.1.4.2 FAS Data Block

The Type 4 Message shall contain the FAS data block for each runway approach served by the LGF. The required content of the data block is defined in the following subsections. This block and its corresponding approach performance designator are broadcast depending on the runway end(s) selected at the ATCU, and the MDT when necessary.

3.2.1.4.2.1 Operation Type

The Operation Type Field shall denote the operation type stored in LGF NVM.

3.2.1.4.2.2 SBAS Provider Identification

The SBAS Provider ID Field shall denote the SBAS service provider ID stored in LGF NVM.

3.2.1.4.2.3 Airport Identification

The Airport Identification Field shall denote the airport identification stored in LGF NVM.

3.2.1.4.2.4 Runway Number

The Runway Number Field shall denote the runway number stored in LGF NVM.

3.2.1.4.2.5 Runway Letter

The Runway Letter Field shall denote the runway letter stored in LGF NVM.

3.2.1.4.2.6 Approach Performance Designator

The Approach Performance Designator Field shall denote the approach PT stored in LGF NVM.

3.2.1.4.2.7 Route Indicator

The Route Indicator Field shall denote the route indicator stored in the LGF NVM.

3.2.1.4.2.8 Reference Path Data Selector

The Reference Path Data Selector Field shall denote the reference path data selector stored in LGF NVM.

3.2.1.4.2.9 Reference Path Identifier

The Reference Path Identifier Field shall denote the reference path identifier stored in LGF NVM.

3.2.1.4.2.10 LTP/FTP Latitude

The LTP/FTP Latitude Field shall denote the LTP/FTP latitude stored in LGF NVM.

3.2.1.4.2.11 LTP/FTP Longitude

The LTP/FTP Longitude Field shall denote the LTP/FTP longitude stored in LGF NVM.

3.2.1.4.2.12 LTP/FTP Height

The LTP/FTP Height Field shall denote the LTP/FTP height stored in LGF NVM.

3.2.1.4.2.13 Delta FPAP Latitude

The Δ FPAP Latitude Field shall denote the Δ FPAP latitude stored in LGF NVM.

3.2.1.4.2.14 Delta FPAP Longitude

The Δ FPAP Longitude Field shall denote the Δ FPAP longitude stored in LGF NVM.

3.2.1.4.2.15 Approach Threshold Crossing Height

The Approach Threshold Crossing Height (TCH) Field shall denote the TCH stored in LGF NVM.

3.2.1.4.2.16 Approach TCH Units Selector

The TCH Units Selector Field shall denote the TCH Unit Selector stored in LGF NVM.

3.2.1.4.2.17 Glidepath Angle

The Glidepath Angle (GPA) Field shall denote the GPA stored in LGF NVM.

3.2.1.4.2.18 Course Width

The Course Width Field shall denote the course width stored in LGF NVM.

3.2.1.4.2.19 Delta Length Offset

The Δ Length Offset Field shall denote the Δ length offset stored in LGF NVM.

3.2.1.4.2.20 FAS CRC

The FAS CRC Field shall denote the FAS CRC stored in LGF NVM.

3.2.1.4.3 FAS VAL/Approach Status

The FAS VAL/Approach Status Field shall denote the FAS VAL or “Do Not Use Vertical" stored in LGF NVM. All ones in this field indicate that vertical guidance is not available.

3.2.1.4.4 FAS LAL/Approach Status

The FAS LAL/Approach Status Field shall denote the FAS LAL or “Do Not Use Approach” stored in the NVM. All ones in this field indicate that the approach is not available.

3.2.2 RADIO FREQUENCY TRANSMISSION CHARACTERISTICS

3.2.2.1 Symbol Rate

The symbol rate of the LGF data broadcast shall be 10,500 symbols per second ±0.005%. Each symbol defines one of eight states (3 bits) resulting in a nominal bit rate of 31,500 bits per second.

3.2.2.2 Emission Designator

The FCC emission designator of this modulation technique is 14K0G7DET.

3.2.2.3 Antenna Polarization

The LGF shall transmit the VHF signal using right hand elliptically polarized antennas.

3.2.2.4 Field Strength

The Effective Radiated Power (ERP) shall provide a field strength not less than 215 μV/m (-99 dBW/m^2) for a horizontally polarized signal. The ERP shall provide a field strength not greater than 350 mV/m (-35 dBW/ m^2) for a horizontally polarized signal. The ERP shall provide a field strength not less than 136 μV/m (-103 dBW/ m^2) for the vertically polarized signal. The ERP shall provide a field strength not greater than 221 mV/m (-39 dBW/ m^2) for the vertically polarized signal.

3.2.2.4.1 Measured Field Strength

Field strength shall be measured as an average over the period of the unique word in the training sequence portion of the message.

3.2.2.4.2 Phase Offset

The RF phase offset between the horizontally polarized and vertically polarized signal components shall be such that the minimum signal power defined in Section 3.2.2.4 is achieved throughout the coverage volume for both users of the horizontally polarized signal and users of the vertically polarized signal.

3.2.2.5 Spectral Characteristics

3.2.2.5.1 Carrier Frequencies

The VDB shall use radio frequencies in the band 108 – 117.950 MHz. The lowest selectable channel shall be 108.025 MHz. The highest selectable channel shall be 117.950 MHz. The separation between selectable frequencies shall be 25 kHz.

3.2.2.5.2 Unwanted Emissions

Unwanted emissions, including spurious and out-of-band emissions, shall be compliant with the levels shown in Table 3-7. The total power in any VDB harmonic or discrete signal shall be no greater than -53 dBm.

Table 3-7. Unwanted Emission Levels

Frequency	Relative Unwanted Emission Level [2]	Maximum Unwanted Emission Level [1]
9 kHz to 150 kHz	-93 dBc	-55 dBm/1kHz [3]
150 kHz to 30 MHz	-103 dBc	-55 dBm/10 kHz [3]
30 MHz to 106.125 MHz	-115 dBc	-57 dBm/100 kHz
106.425	-113 dBc	-55 dBm/100 kHz
107.225	-105 dBc	-47 dBm/100 kHz
107.625	-101.5 dBc	-53.5 dBm/10 kHz
107.825	-88.5 dBc	-40.5 dBm/10 kHz
107.925	-74 dBc	-36 dBm/1 kHz
107.975	-65 dBc	-27 dBm/1 kHz
118.000	-65 dBc	-27 dBm/1 kHz
118.050	-74 dBc	-36 dBm/1 kHz
118.150	-88.5 dBc	-40.5 dBm/10 kHz
118.350	-101.5 dBc	-53.5 dBm/10 kHz
118.750	-105 dBc	-47 dBm/100 kHz
119.550	-113 dBc	-55 dBm/100 kHz
119.850 to 1 GHz	-115 dBc	-57 dBm/100 kHz
1 GHz to 1.7 GHz	-115 dBc	-47 dBm/1MHz

Note 1. The maximum unwanted emission level (absolute power) applies if the authorized transmitter power exceeds 150 W.

Note 2. The relative unwanted emission level is to be computed using the same bandwidth for desired and unwanted signals. This may require conversion of the measurement for unwanted signals done using the bandwidth indicated in the maximum unwanted emission level column of Table 3-7.

Note 3. This value is driven by measurement limitations. Actual performance is expected to be better.

Note 4. The relationship is linear between single adjacent points designated by the adjacent channels identified in Table 3-7.

3.2.2.6 Adjacent Channel Emissions

The amount of power during transmission under all operating conditions when measured over a 25 kHz bandwidth centered on any adjacent channel shall not exceed the values given in Table 3-8:

Table 3-8. Adjacent Channel Emissions

Channel	Relative Power	Maximum Power
1st Adjacent	-40 dBc	12 dBm
2nd Adjacent	-65 dBc	-13 dBm
4st Adjacent	-74 dBc	-22 dBm
8st Adjacent	-88.5 dBc	-36.5 dBm
16st Adjacent	-101.5 dBc	-49.5 dBm
32st Adjacent	-105 dBc	-53 dBm
64st Adjacent	-113 dBc	-61 dBm
76st Adjacent and beyond	-115 dBc	-63 dBm

Note 1. The maximum power applies if the authorized transmitter power exceeds 150 W.

Note 2. The relationship is linear between single adjacent points designated by the adjacent channels identified in Table 3-8.

3.2.2.6.1 Adjacent Temporal Interference

Under all operating conditions, the maximum power over a 25 kHz bandwidth, centered on the assigned frequency, when measured over any unassigned time slot, shall not exceed -105 dBc referenced to the authorized transmitter power.

3.2.2.6.2 Frequency Stability

The long-term stability of the transmitter carrier frequency shall be ± 0.0002%.

3.2.2.7 Modulation

Binary data shall be assembled into symbols, each consisting of 3 consecutive bits. The end of the data shall be padded by up to two fill bits if necessary to form the last 3-bit symbol of the burst. Symbols shall be converted to differentially encoded 8 phase shift keyed (D8PSK) carrier phase shifts (? ϕ_k) as shown in Table 3-9.

The carrier phase for the k^{th} symbol (ϕ_k) is given by

$$\phi_k = \phi_{k-1} + \Delta\phi_k. \qquad (19)$$

The transmitted signal shall be

$$H(e^{j(2pft + \phi(t))}) \qquad (20)$$

where H(•) is a raised cosine filter with α=0.6 as defined in Section 3.2.2.7.1.

Table 3-9. Data Encoding

Message Bits (note)			**Symbol Phase Shift**
$\mathbf{I_{3k-2}}$	$\mathbf{I_{3k-1}}$	$\mathbf{I_{3k}}$	D $f_{\mathbf{k}}$
0	0	0	0
0	0	1	1π/4
0	1	1	2π/4
0	1	0	3π/4
1	1	0	4π/4
1	1	1	5π/4
1	0	1	6π/4
1	0	0	7π/4

Note: I_j is the j^{th} bit of the burst to be transmitted, where I_1 is the first bit of the training sequence. The values of D f_k represent counter clockwise rotations in the complex I-Q plane of Figure 2-1 of RTCA/DO-246A.

3.2.2.7.1 Pulse Shaping Filters

The output of differential phase encoder shall be filtered by a pulse shaping filter whose output, s(t), is

$$s(t) = \sum_{k=-\infty}^{k=\infty} e^{j f_k} h(t - kT) \qquad (21)$$

where h = the impulse response of the raised cosine filter t = time

T = duration of each symbol (T=1/10500 second, approximately 95.2 μsec) and

ϕ_k = as defined in Section 3.2.2.7.

This pulse shaping filter shall have a nominal complex frequency response of a raised-cosine filter with α = 0.6. The frequency response, *H(f)*, and the time response, *h(t)*, of the base band filters shall be in accordance with

$$H(f)=\begin{cases} 1 & 0< f <\dfrac{1-a}{2\mathrm{T}} \\ \dfrac{1-\sin\left(\dfrac{p}{2a}(2f\mathrm{T}-1)\right)}{2}, & \dfrac{1-a}{2\mathrm{T}} \le f \le \dfrac{1+a}{2\mathrm{T}} \\ 0 & f >\dfrac{1+a}{2\mathrm{T}} \end{cases} \tag{22}$$

$$h(t)=\frac{\sin\left(\dfrac{pt}{T}\right)\cos\dfrac{pat}{T}}{\dfrac{pt}{T}\left[1-\left(\dfrac{2at}{T}\right)^2\right]} \tag{23}$$

where *f* is the absolute value of the frequency offset from the channel center,

T is the symbol period of 1/10500 seconds (approximately 95.2 μ seconds),

t is time, and

a is 0.6.

3.2.2.7.2 Error Vector Magnitude

The error vector magnitude of the transmitted signal shall be less than 6.5% RMS of the desired signal magnitude at the center of the symbol.

3.2.2.8 Burst Data Content

Burst Data Content shall comply with Section 2.3 of RTCA/DO-246A.

3.2.2.9 Broadcast Timing Structure Division Multiple Access

The broadcast timing structure shall comply with Section 2.2 of RTCA/DO-246A. The LGF shall be capable of transmitting in any two of eight time slots within each frame. The LGF shall be capable of broadcasting in a minimum of two slots per frame per VDB antenna. In every frame, the LGF shall broadcast a message in every slot designated in LGF NVM.

3.2.3 RADIO FREQUENCY BROADCAST MONITORING

The data broadcast transmissions shall be monitored. The transmission of the data shall cease within 0.5 seconds when any of the following conditions exist:

a. continuous disagreement for any 3 second period between the transmitted application data and the application data derived or stored by the monitoring system prior to transmission,

b. a transmitted power offset of more than 3 dB from the on-channel assigned power for 3 seconds,

c. more than 0.2% of messages in the last hour are not transmitted,

d. no transmission for 3 seconds, or

e. any transmitted data outside of the assigned TDMA time slots for 3 seconds.

Conditions 'a' – 'e' include the time to switch to redundant equipment, if available.

3.3 OPERATION AND MAINTENANCE

Operations and maintenance functions are provided via internal and external LGF components. These components include:

a. LSP (internal)

b. MDT (external)

c. RSP (external)

d. ATCU (external)

e. LGF Built-in-Test (BIT) (internal)

f. Recording (internal, Sections 3.3.3.1 and 3.3.3.2)

g. Recording (external, Sections 3.3.3.3 and 3.3.3.4)

Figure 3-4 provides a high-level diagram depicting the functional relationship between the LGF and Operations and Maintenance.

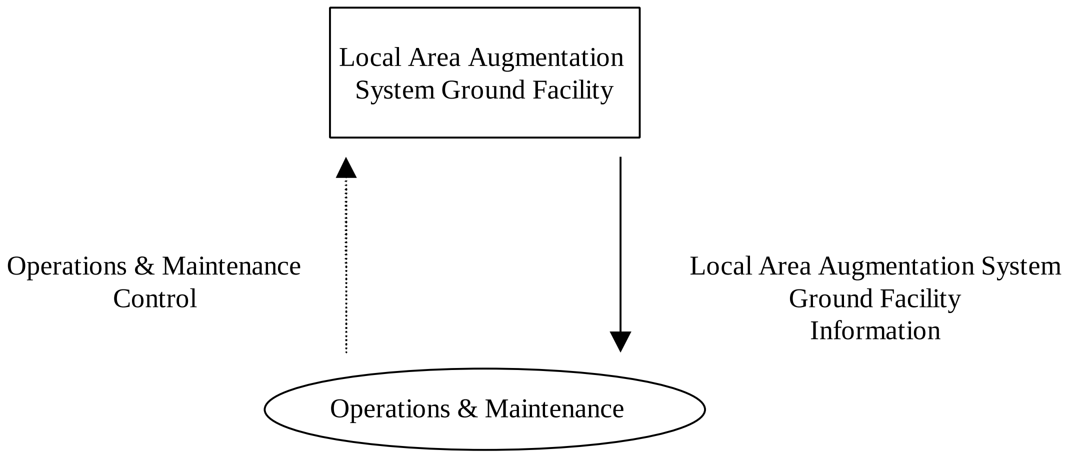

Figure 3-4. Operations and Maintenance

The internal and external interfaces of the LGF are depicted in Figure 3-5.

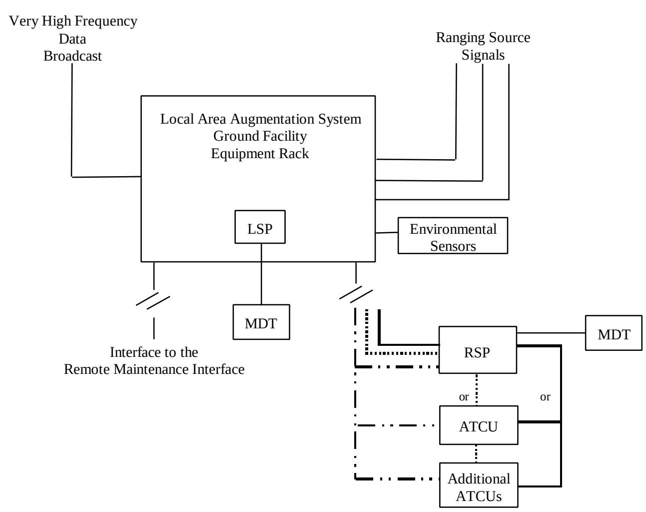

Figure 3-5. Local Area Augmentation System Ground Facility Interfaces

3.3.1 SYSTEM REQUIREMENTS

3.3.1.1 Environmental Design Values

Environmental design values for the LGF shall comply with the environmental conditions of Table 3-10.

3.3.1.1.1 Environmental Service Conditions

LGF equipment intended for use in attended facilities shall be designed for the ambient conditions of Environment I in Table 3-10. LGF equipment intended for use in unmanned facilities shall be designed for the ambient conditions of Environment II listed in Table 3-10.

LGF equipment not housed in shelters shall be designed for the ambient conditions of Environment III listed in Table 3-10.

Table 3-10. Environmental Conditions

Environment[1]	Temperature (°C)	Relative Humidity[3] (%)	Altitude (ft above sea level)	Wind (mph)	Ice Loading	Rain
I	+10 to +50	10 to 80	0 to 10,000	--	--	--
II	0 to +50	5 to 90	0 to 10,000	--	--	--
III[4]	-50 to +70[2]	5 to 100	0 to 10,000	0 to 100	Encased in ½"radial thickness clear ice	2" / hour

1. I For equipment installed in an attended facility.
II For equipment installed in an unattended facility.
III For equipment installed outdoors (antennas, field detectors)
2. Includes 18°C for solar radiation.
3. Above 40°C, the relative humidity shall be based upon a dew point of 40°C.
4. Conformal coating is required only when equipment is exposed to salt atmosphere or located in tropical climates.

3.3.1.1.2 Wind and Ice Loading

Wind and ice loading values for LGF externally exposed equipment shall comply with Section 3.2.1.2.3 of FAA-G-2100F.

3.3.1.1.3 Non-Operating Conditions

Shipped, stored, and transported equipment for the LGF shall comply with Section 3.2.1.2.4 of FAA-G-2100F.

3.3.1.2 Primary Power

The LGF shall operate from a nominal 120 volt, 60 Hz, three wire, single phase AC power source.

3.3.1.3 Supplementary Power

The LGF shall include an uninterruptible supplementary power source. The supplementary power source shall continuously power the LGF for a period of not less than four hours after a loss of primary power under nominal conditions. Nominal conditions are defined to be a room temperature of 30° C and a Voltage Standing Wave Ration (VSWR) of 1.5:1.

3.3.1.3.1 Power Supply

The LGF shall automatically sense when the supplementary power discharge point is reached. When operating on supplementary power, the LGF shall initiate facility shutdown if a critical discharge point is met. The LGF shall have the capability to self-restore to operate on primary power upon restoration of primary power. To maintain the supplementary power in operational readiness, a trickle charge shall be supplied to recharge the supplementary power during the period of available primary power. Upon loss and subsequent restoration of primary power, the LGF supplementary power shall restore to a full charge condition from a 50% discharge condition within 8 hours. The LGF shall continue at the same level of service upon restoration of primary power.

3.3.1.4 Environmental Sensors

The LGF design shall include an

a. intrusion detector sensor,
b. smoke detector sensor,
c. obstruction lights sensor,
d. AC power sensor,
e. inside temperature sensor, and
f. outside temperature sensor.

The environmental sensor output shall be processed by the LGF and retrievable by the MDT. The LGF shall be capable of bypassing any sensor that is not utilized.

3.3.1.4.1 Intrusion Detector

The intrusion detector shall detect when the LGF shelter door has been opened for any period greater than 0.50 seconds. The LGF shall generate a service alert message if valid log-on ID and password entries are not received within 5 minutes of detecting an open shelter door. The LGF shall provide the capability to arm and bypass the intrusion detector through the MDT.

3.3.1.4.2 Smoke Detector

The smoke detector shall be an ionization-type smoke detector. The smoke detector shall meet the requirements of Underwriters Laboratories (UL), Inc. Standard 268. The smoke detector shall bear the UL, Inc. label. The LGF shall generate a service alert upon detection of combustion products.

3.3.1.4.3 Obstruction Lights

The LGF shall identify when a lamp has failed in the obstruction light assembly of the antennas. The LGF shall generate an alert message when a lamp fails.

3.3.1.4.4 AC Power

The AC power sensor shall detect the presence of primary AC power. The AC power sensor shall detect the absence of acceptable primary AC power. The LGF shall generate a service alert when a loss of AC power is detected.

3.3.1.4.5 Inside Temperature

The inside temperature sensor shall provide the temperature inside the LGF equipment shelter to the LGF, with a minimum resolution of one-degree centigrade. The accuracy over the range of -10º to +50º centigrade shall be ± 5º centigrade without calibration. The LGF shall generate an alert when the temperature has exceeded the alert thresholds. The LGF shall generate a service alert message when the upper and lower temperature design thresholds are exceeded.

3.3.1.4.6 Outside Temperature

The outside temperature sensor shall provide the temperature outside the LGF equipment shelter to the LGF with a minimum resolution of no less than one-degree centigrade. The accuracy over the range of -50° to +70° centigrade shall be ± 5° centigrade without calibration.

3.3.1.5 Fault Diagnostics, Built-in-Test, and Isolation Procedures

The LGF shall include the capability to perform automatic and manually-initiated fault diagnosis to the LRU level. The resulting data shall be stored in memory until manually cleared via the MDT. Stored data shall be accessible via the MDT. Manually initiated diagnostics shall be available from the MDT. A combination of fault diagnostics, BIT, and manual isolation shall provide for the following actions:

a. automatically initiating the diagnostic routine when an alarm occurs,

b. automatic diagnostic fault isolation rates at 90% or greater to an ambiguity group of three LRUs or less, and

c. manual isolation to a single LRU 100% of the time.

3.3.1.6 Maintainability of Electronic Equipment

3.3.1.6.1 Maintenance Concept

The LGF shall provide for a site and depot concept of maintenance. This concept assumes the use of modular equipment that enables maintenance specialists to correct a majority of equipment failures on-site by replacing the faulty LRU.

3.3.1.6.2 Unscheduled Maintenance

3.3.1.6.2.1 Reliability

The mean time between unscheduled maintenance actions for the LGF shall be at least 2190 hours. The mean time between unscheduled maintenance actions for the ATCU shall be a minimum of 40,000 hours. Unscheduled maintenance actions are those actions required to correct an alarm or service alert condition. These actions exclude environmental service alerts.

3.3.1.6.2.2 Maintainability

The Mean-Time-to-Repair (MTTR) shall be less than 30 minutes. The repair time shall include

a. diagnostic time,

b. removal of the failed LRU,

c. installation of the new LRU,

d. initialization of the new LRU, and

e. all adjustments required to return the LGF to Normal Mode.

Any replacement of a failed LRU that does not require a re-certifying flight check may be completed while the LGF is in Normal Mode.

3.3.1.6.3 Periodic Maintenance

Periodic maintenance for the LGF shall not interrupt service for more than eight hours per year of operation. No single group of periodic procedures shall be required more frequently than every 2190 hours. Periodic maintenance for the RSP shall not exceed one hour in 4380 hours of operation. Periodic maintenance for the ATCU shall not exceed one hour in 4380 hours of operation. Periodic maintenance shall include the time required to complete the routine checks and inspections necessary to assure normal operation.

The capability to isolate latent faults affecting integrity and continuity shall be provided through the MDT. Isolation of latent failures shall be provided through either embedded equipment, software, or with special test equipment.

3.3.1.6.4 System Specialist Workload

Completion of corrective and periodic maintenance actions shall require no more than two system specialists.

3.3.1.7 Security

The internal and external LGF components shall provide for protection of internally stored information and information transfer in accordance with FAA Order 1370.82.

3.3.1.7.1 System Identifiers and Authenticators

The internal and external components of the LGF shall provide restrictive access via log-on implementation. Security authentication shall ensure only authorized personnel can log-on successfully. LGF displays shall display a warning banner approved by the Office of the Chief Information Officer (CIO) and the Officer of the Chief Counsel (AGC) to each user before login.

3.3.1.7.1.1 Security Levels

All information pertaining to the LGF has been assigned a minimum security level of Commercial Security (CS) 2 in accordance with FAA Order 1370.82.

3.3.1.7.1.2 Read Access

The capability to view LGF internally stored data and diagnostic information shall be provided at the RSP and LSP interface with an MDT. Provisions for read access at the RMDT port shall be provided.

Note: The RMDT capability is expected to be utilized at a later date, yet to be determined.

3.3.1.7.1.3 Write Access

The capability to load FAS data, input site specific parameters, and all other maintenance actions shall be provided at the LSP and RSP with an MDT in accordance to Sections 3.3.1.7.1.3.1 and 3.3.1.7.1.3.2.

3.3.1.7.1.3.1 Write Access – LSP

Write access shall be provided at the LSP for Test Mode, Normal Mode, and Not Available Mode.

3.3.1.7.1.3.2 Write Access – RSP

Write access shall be provided at the RSP for Normal Mode and Not Available Mode.

3.3.1.7.2 User Identifications and Passwords

User IDs and passwords for the LGF shall accommodate a minimum combination of six alphanumeric characters and a maximum combination of eight alphanumeric characters. The LGF shall accommodate 24 user ID and password combinations. The ability to add, delete, and modify user IDs and passwords shall be preceded by a password confirmation prompt. User IDs shall be visible to the log-on terminal. User ID and password lists shall be immediately and automatically updated to reflect changes entered at an MDT.

3.3.1.7.2.1 Logical Access Control

Logical access to files and objects shall be restricted via password and user IDs. Logical access levels shall include the following:

a. Access Level 1: Read Only – General Use

b. Access Level 2: Read/Write – Certified Maintenance Specialist

c. Access Level 3: Administrative – Full Access

3.3.1.7.3 Invalid User Identification or Password Entry

An invalid logon entry attempt shall cause

a. an error message indicating "Invalid User ID or Password" to be output to the MDT,
b. the access procedure to be terminated after three consecutive invalid entries,
c. the LGF logon process to return to idle, and
d. a user to be inhibited from access for a period of 15 minutes after three invalid entries.

3.3.1.7.4 Log-on Time-out

The LGF shall provide a time-out that requires the log-on procedure to be repeated if the interface is idle for more than 15 minutes. Any valid message transmitted over the interface shall re-initiate the timeout.

3.3.1.8 Physical Design and Packaging

The LGF and the status and control subsystem component equipment shall be designed and packaged as to facilitate the accomplishment of all testing, adjustments, and maintenance procedures.

3.3.1.9 Electrical

3.3.1.9.1 Electrical Wiring

Electrical wiring shall comply with Section 3.1.2.1 of FAA-G-2100F.

3.3.1.9.1.1 External Wiring

External wiring to equipment that interfaces with the power source shall be in accordance with the National Electrical Code (NFPA 70), FAA-STD-032, and FAA-C-1217.

3.3.1.9.2 Alternating Current Line Controls

Each control switch, relay, circuit breaker, fuse, or other device that acts to disconnect the AC supply line energizing the LGF equipment shall be in accordance with NFPA 70 or UL 1950 for Information Technology Equipment.

3.3.1.9.3 Main Power Switch

The LGF shall have a front panel-mounted main power switch(es) labeled “On/Off”. Each rack shall have a switch that is clearly indicated for emergency shut-down. Main power termination shall include supplementary power termination. Power down sequences must be published and made accessible to operators. Switches or circuit breakers that function as main power switches shall comply with Section 3.1.2.2.2 of FAA-G-2100F.

3.3.1.9.4 AC Line-Input Resistance to Ground

Each individual chassis unit connected to the AC supply line shall comply with Section 3.1.2.2.3 of FAA-G-2100F.

3.3.1.9.5 AC Line Connectors and Power Cord

Plugs, receptacles, and power cords provided for connecting the equipment to the AC supply line shall meet the requirements of NFPA 70 and be in accordance with Section 3.1.2.2.4 of FAA-G-2100F.

3.3.1.9.6 AC Line Controls

Each equipment unit energized by direct connection to the AC line shall comply with Section 3.1.2.2.5 of FAA-G-2100F.

3.3.1.9.7 Transformer Isolation, Direct Current Power Supplies

All non-switching Direct Current (DC) power supplies energized from the AC line power source shall be in accordance with Section 3.1.2.2.6 of FAA-G-2100F.

3.3.1.9.8 Voltage Regulators

External voltage regulating transformers shall not be used. Voltage regulation in the equipment shall be provided by voltage or current regulators, or both, in the DC output circuit of the power supplies.

3.3.1.9.9 Convenience Outlets

Convenience outlets provided on the equipment cabinets shall be in accordance with Section 3.1.2.2.7 of FAA-G-2100F.

Note: Only the minimum number of convenience outlets necessary for maintenance should be provided.

3.3.1.9.10 Circuit Protection

All equipment power output circuits shall be designed to include circuit protection in accordance with Section 3.1.2.3 of FAA-G-2100F.

3.3.1.9.11 Electrical Overload Protection

3.3.1.9.11.1 Current Overload Protection

Current overload protection for equipment shall be in accordance with Section 3.1.2.4.4.1 of FAA-G-2100F.

3.3.1.9.11.2 Protective Devices

Protective devices for wired-in equipment shall be in accordance with Section 3.1.2.4.4.2 of FAA-G-2100F.

3.3.1.9.12 Circuit Breakers

Circuit breakers shall be in accordance with Section 3.1.2.4.4.3 of FAA-G-2100F.

3.3.1.9.12.1 Short Circuit Coordination

Short circuit coordination shall comply with Section 3.1.2.4.4.3.1 of FAA-G-2100F.

3.3.1.9.12.2 Normal Performance

The use of overload or other protective devices shall comply with Section 3.1.2.4.4.4 of FAA-G-2100F.

3.3.1.9.13 Test Points and Test Equipment

Functional checks and trouble shooting of the LGF shall be possible through the provision of test points that are readily accessible.

3.3.1.9.13.1 Built-in-Test Device Requirements

BIT devices shall comply with Section 3.1.2.5.1 of FAA-G-2100F.

3.3.1.9.13.2 Location of Test Points and Adjustment Controls

Location of test points and adjustment controls shall comply with Section 3.1.2.5.3 of FAA-G-2100F.

3.3.1.9.13.3 Test Point Circuitry Protection

Test point circuitry protection shall comply with Section 3.1.2.5.4 of FAA-G-2100F.

3.3.1.9.13.4 Failure

BIT devices shall comply with Section 3.1.2.5.5 of FAA-G-2100F.

3.3.1.9.14 Electrical Breakdown Prevention

Preventative measures for electrical breakdown shall be in accordance with Section 3.1.2.6.2 of FAA-G-2100F.

3.3.1.9.15 Grounding, Bonding, Shielding, and Transient Protection

Grounding, bonding, shielding, and transient protection for the LGF shall be in accordance with FAA-STD-020 for Non-Developmental Items (NDI) and developmental items. At the facility interface, the requirements for grounding, bonding, shielding, and transient protection shall be in accordance with NFPA 70 and shall not violate the requirements of FAA-STD-020. If the item is to be UL-recognized, protective measure shall be in accordance with UL 1950 for Information Technology Equipment.

3.3.1.9.16 Obstruction Lights

A double obstruction light assembly shall be provided, where required, in accordance with FAA AC 150/5345-43E and FAA AC 70/7460-1J. The lamps shall be wired in parallel. The lamps shall be rated at 100 watts each.

3.3.1.9.17 Power Factor

The power factor shall comply with the requirements in Section 9.J(4) of FAA Order 6950.2D.

3.3.1.9.18 Peak Inrush Current

Peak inrush current and total current harmonic distortion shall meet the requirements of Section 3.1.2.4.3 of FAA-G-2100F and Sections 9.J(3) and 9.J(5) for FAA Order 6950.2D.

3.3.1.10 Markings

Markings shall be permanent and legible.

3.3.1.10.1 Radio Frequency Connectors

Markings for RF connectors shall comply with Section 3.3.3.2.2.1 of FAA-G-2100F.

3.3.1.10.2 Fuse Markings

Markings for fuse positions shall comply with Section 3.3.3.2.2.4 of FAA-G-2100F.

3.3.1.10.3 Terminal Strips and Blocks

Markings for terminal strips and blocks shall comply with Section 3.3.3.2.2.5 of FAA-G-2100F.

3.3.1.10.4 Controls and Indicating Devices

Markings for controls and indicating devices shall comply with Section 3.3.3.2.2.7 of FAA-G-2100F.

3.3.1.10.5 Nameplates

Furnished equipment shall have one or more nameplates as determined by the equipment configuration in accordance with Figure IV of FAA-G-2100F.

3.3.1.10.6 Safety Related Markings

Guards, barriers or access doors, covers, and plates shall be marked to indicate the hazard that may be reached upon removal of such devices. When possible, marking shall be located such that it is not removed when the barrier or access door is removed. Warnings of hazards internal to a unit shall be marked adjacent to hazards if they are significantly different from those of surrounding items. Such a case would be a high voltage terminal in a group of low voltage devices.

3.3.1.10.6.1 Physical Hazards

Physical hazards shall be marked with color codes in accordance with American National Standards Institute (ANSI) Z535.l where applicable to electronic equipment.

3.3.1.10.6.2 Center-of-Gravity

Center-of-Gravity shall be marked on all equipment with a center-of-gravity 50% different from the Center-of-Volume of the chassis.

3.3.1.10.7 Accident Prevention Signs and Labels

Accident prevention signs and labels shall be in accordance with Section 3.3.6.5.2 of FAA-G-2100F.

3.3.1.10.8 Sign Design

Sign design shall be in accordance with Section 3.3.6.5.2.1 of FAA-G-2100F.

3.3.1.10.9 Sign Classification and Detailed Design

3.3.1.10.9.1 Class I - Danger Classification

Signs indicating immediate and grave danger or peril, a hazard capable of producing irreversible damage or injury, and prohibitions against harmful activities shall be in accordance with Section 3.3.6.5.2.2.1 of FAA-G-2100F.

3.3.1.10.9.2 Class II - Caution Classification

Signs used to call attention to potential danger or hazard, or a hazard capable of or resulting in severe but not irreversible injury or damage shall be in accordance with Section 3.3.6.5.2.2.2 of FAA-G-2100F.

3.3.1.10.9.3 Class III - General Safety Classification

Signs of general practice and rules relating to health, first aid, housekeeping, and general safety shall be in accordance with Section 3.3.6.5.2.2.3 of FAA-G-2100F.

3.3.1.10.9.4 Class IV - Fire and Emergency Classification

Signs used to label and point the way to fire extinguishing equipment, shutoffs, emergency switches, and emergency procedures shall be in accordance with Section 3.3.6.5.2.2.4 of FAA-G-2100F.

3.3.1.11 Personnel Safety and Health

The design and development of electronic equipment shall provide for the safety of personnel during the installation, operation, maintenance, repair, and interchange of complete equipment assemblies or component parts. Equipment design for personnel safety shall be equal to or better than the requirements of the Occupational Safety and Health Act (OSHA) as identified in CFR Title 29, Part 1910.

3.3.1.11.1 Human Factors Engineering

When establishing general and detailed design criteria, elements affecting safety shall be human factors engineered. The designs shall eliminate or mitigate hazards associated with

a. hazardous components,
b. safety-related interface considerations between the equipment and other portions of the system,
c. environmental constraints including the operating environment,
d. operating, test, maintenance, and emergency procedures,
e. facilities and support equipment, and
f. safety related equipment, safeguards, and possible alternate approaches.

3.3.1.11.2 Electrical Safety

Personnel shall be protected with respect to electrical contact in accordance with Section 3.3.6.1 of FAA-G-2100F.

3.3.1.11.2.1 Ground Potential

Grounding of external parts, surfaces, and shields shall be in accordance with Section 3.3.6.1.1 of FAA-G-2100F.

3.3.1.11.2.2 Hinged or Slide Mounted Panels and Doors

Hinged or slide mounted panels and doors shall be grounded in accordance with Section 3.3.6.1.2 of FAA-G-2100F.

3.3.1.11.2.3 Shielding

Shielding on wire and cable shall be grounded in accordance with Section 3.3.6.1.3 of FAA-G-2100F except when a conflict with the grounding requirements of Section 3.3.1.9.15 would be created.

3.3.1.11.2.4 Radio Frequency Voltage Protection

Personnel shall be protected from accidental contact with transmitter output terminals, antennas, and devices that carry sufficient RF voltage to cause injury.

3.3.1.11.2.5 Electrical Connectors

Electrical connectors shall comply with Section 3.3.6.1.12 of FAA-G-2100F.

3.3.1.11.3 Radio Frequency Limits

3.3.1.11.3.1 Applicability of Federal Standards

Equipment design for which a federal standard exists under the CFR Title 21, Chapter I, Subchapter J shall conform to the appropriate federal standard.

3.3.1.11.3.2 Radiation Hazards and Protection

All electronic equipment or electrical devices capable of emitting x-radiation or RF/microwave radiation between 300 kHz and 100 GHz shall be designed, fabricated, shielded, and operated to the requirements of FAA Order 3900.19B.

3.3.1.11.4 Cathode Ray Tubes

Cathode ray tubes shall conform to the requirements of UL Standard 1418, where applicable.

3.3.1.12 Hazardous and Restricted Materials

Assessment of the hazard potential of a substance and its decomposition products shall be performed before material selection. This assessment shall include those materials listed in Section 3.3.6.6 of FAA-G-2100F.

3.3.1.13 Federal Communications Commission Type Acceptance and Registration

The first production equipment shall be subjected to the Federal Communication Commission (FCC) type acceptance and registration procedures in accordance with the FCC Rules and

Regulations of the CFR, Title 47, Part 2, Part 68, and Part 87. The environmental temperature range specified by the FCC shall supersede, for the purposes of the FCC Type Acceptance Procedures, the service condition temperature range that is applicable under the equipment specification and this specification. Compliance with FCC Regulations shall be maintained with regards to any approved changes made to the production equipment that is relevant to the FCC Type Acceptance or Registration.

3.3.2 CONTROL AND DISPLAY

All control and display units shall be designed in accordance with Human Factors guidelines, defined in Section 3.3.7 of FAA-G-2100F.

3.3.2.1 Local Status Panel

An LSP shall be provided as the on-site maintenance interface to the LGF. The LSP shall provide two female DB-9 connectors for the RMDT and MDT maintenance interfaces to the LGF.

3.3.2.1.1 LSP – Modes and Service Alerts

The LSP shall annunciate

a. Green for Normal,

b. Red for Not Available,

c. Yellow for Test, and

d. Orange for Service Alert.

The LSP shall display a change in mode and service alerts within 3 seconds of detection by the LGF.

3.3.2.1.1.1 LSP – Initialization

The LSP shall simultaneously annunciate green, red, yellow, and orange during a power up, manual reset, or automatic restart.

3.3.2.1.2 LSP – Aural Signal

The LSP shall initiate a steady tone aural signal when the LGF is Not Available. The LSP shall initiate an intermittent beep aural signal when there is a service alert.

3.3.2.1.3 LSP – Mute Switch

The LSP shall provide the capability to manually silence an aural signal.

3.3.2.2 Remote Status Panel

An RSP shall be provided as an external interface, located within 50 miles of the airport. The RSP shall provide two female DB-9 connectors for the RMDT and MDT maintenance interfaces to the LGF.

3.3.2.2.1 RSP – Modes and Service Alerts

The RSP shall annunciate

a. Green for Normal,

b. Red for Not Available,

c. Yellow for Test, and

d. Orange for Service Alert.

The RSP shall display a change in mode and service alerts within 3 seconds of detection by the LGF.

3.3.2.2.1.1 RSP – Initialization

The RSP shall simultaneously annunciate green, red, yellow, and orange during a power up, manual reset, or automatic restart.

3.3.2.2.2 RSP– Aural Signal

The RSP shall initiate a steady tone aural signal when the LGF is Not Available. The RSP shall initiate an intermittent beep aural signal when there is a service alert.

3.3.2.2.3 RSP – Mute Switch

The RSP shall provide the capability to manually silence an aural signal.

3.3.2.2.4 RSP – Supplementary Power

The RSP shall include the capability to remain continuously powered for at least two hours of uninterrupted operation via a supplementary power source after the loss of primary AC power. Restoration of primary power shall not negatively effect the operation of the respective subsystems.

3.3.2.3 Maintenance Data Terminal

An MDT shall be provided, interfacing to the LGF through the LSP and RSP, to a distance of 20 ft. The MDT shall follow the security requirements of Section 3.3.1.7. All manually entered data shall be stored in LGF NVM. The MDT shall be provided with a 3 ½" floppy disk drive. A computer virus check for malicious code shall be performed on any data to be transferred to the

LGF via the MDT. Malicious code is defined as an unauthorized attempt to include software or firmware that is capable of corrupting the operation of the LGF.

3.3.2.3.1 MDT Control and Display

The MDT shall provide the capability to command and monitor all test and maintenance actions available through the interface.

3.3.2.3.1.1 Restart

The MDT shall provide the capability to restart the LGF. Commanding restart shall cause all program variables and all software and firmware controlled hardware to be initialized to a predefined condition from which normal program execution can continue.

3.3.2.3.2 States and Modes Display

The MDT shall provide the capability to display the current LGF state and mode, defined in Section 3.1.4.

3.3.2.3.3 Alerts and Alarm Display

The MDT shall provide the capability to display, within 3 seconds, all alert and alarm messages generated by the LGF.

3.3.2.3.4 VDB Display

The MDT shall display the VDB status as either transmitting or not transmitting. The MDT shall provide the capability to display the VDB message type and data fields.

3.3.2.3.5 VDB Control

The MDT shall provide the capability to activate and deactivate the VDB. VDB deactivate shall by-pass the VDB antenna and terminate into a dummy load.

3.3.2.3.6 VDB Message Data

The MDT shall provide the capability to adjust the following VDB message data for each message type and parameter:

a. Message Header
    1. Reference Station ID
b. Type 1 Message
    1. Measurement Type
    2. Sigma Pseudorange Ground
c. Type 2 Message

1. LGF Installed RRs
2. LGF Accuracy Designator
3. Local Magnetic Variation
4. Refractivity Index
5. Scale Height
6. Refractivity Uncertainty
7. Latitude
8. Longitude
9. Vertical Ellipsoid Offset

d. Type 4 Message

1. Data Set Length
2. FAS Data Block - manually entered as a block in its entirety:
    a) Operation Type
    b) SBAS Provider Identification
    c) Airport Identification
    d) Runway Number
    e) Runway Letter
    f) Approach Performance Designator
    g) Route Indicator
    h) Reference Path Data Selector
    i) Reference Path Identifier
    j) LTP/FTP Latitude
    k) LTP/FTP Longitude
    l) LTP/FTP Height
    m) Δ FPAP Latitude
    n) Δ FPAP Longitude
    o) Approach TCH Height
    p) Approach TCH Unit Selector
    q) GPA
    r) Course Width
    s) Δ Length Offset
    t) FAS CRC

3. FAS VAL/Approach Status – Lateral Navigation (LNAV) Only
4. FAS LAL/Approach Status – Approach Not Available

3.3.2.3.7 System Power Display

The MDT shall provide the capability to display the LGF power source.

3.3.2.3.8 Alerts and Alarm Status Display

The MDT shall provide the capability to display the status of all existing alerts and alarms.

3.3.2.3.9 Alerts and Alarm Threshold Display

The MDT shall provide the capability to display the thresholds and tolerances for alert, service alert, constellation alert, and alarm parameters, as defined in Sections 3.1.5.1.2, 3.1.5.1.3, 3.1.5.1.4, and 3.1.5.1.5.

3.3.2.3.10 Alerts and Alarm Threshold Control

The MDT shall provide the capability to modify the thresholds for alert, service alert, constellation alert, and alarm parameters, as defined in Sections 3.1.5.1.2, 3.1.5.1.3, 3.1.5.1.4, and 3.1.5.1.5. The ability to change a parameter setting, in minimum steps, consistent with individual parameter ranges shall be provided. The ability to manually enter a parameter setting within design tolerances shall be provided.

3.3.2.3.11 Monitor By-Pass

3.3.2.3.11.1 By-Pass Annunciation

The MDT shall provide the capability to by-pass the aural annunciation of all alerts and alarms to the LSP, RSP, or ATCU, or all simultaneously while the LGF is in the Test Mode. The MDT by-pass annunciation function shall provide a configurable default setting.

3.3.2.3.11.2 By-Pass Actions

The MDT shall provide the capability to by-pass the VDB shut-down action associated with Section 3.2.3 item ‘b’.

Note: This capability is provided for maintenance purposes.

3.3.2.3.12 Static Site Data Display

The MDT shall provide the capability to display the following site-specific parameters:

a. VDB Frequency,
b. VDB Power,

c. TDMA Time Slot(s),

d. RR Geodetic Coordinates,

e. Reception Mask, and

f. σ_{rrc}, the one sigma range rate correction error.

3.3.2.3.13 Static Site Data Control

The MDT shall provide the capability to input the following site-specific parameters:

a. VDB Frequency, 108.025 MHz to 117.950 MHz in 25 kHz channels,

b. VDB Power Adjustment,

c. TDMA Time Slot(s),

d. RR Geodetic Coordinates (WGS-84),

e. Reception Mask, and

f. σ_{rrc}, the one sigma range rate correction error.

3.3.2.3.14 Approach Status Display

The MDT shall simultaneously display the approach status for up to 16 runway ends. The MDT shall display the enable, disable, and Lateral Navigation (LNAV) status of each runway end supported by the LGF.

3.3.2.3.15 Approach Control

The MDT shall include the capability to simultaneously enable all approaches associated with each runway end served by the LGF. The MDT shall include the capability to simultaneously disable all approaches associated with each runway end served by the LGF. This capability will enable or disable all approaches to a runway end with a single action.

3.3.2.3.16 Redundant Equipment Status Display

The MDT shall provide the capability to display the status for both classifications of LGF equipment, Main and Standby. Main and Standby equipment and the possible status shall be:

a. Main – Primary LGF Equipment

   1. On-line – Primary LGF equipment is on-line and operational.
   2. Failed – Equipment has failed and is not available for operational use.
   3. Disabled – Equipment has been disabled.

b. Standby – Backup/redundant LGF Equipment

   1. Available – Equipment is functional and is available for switchover following a main equipment failure.
   2. Failed – Equipment has failed and is not available for operational use.

3. Disabled – Equipment has been disabled.
4. On-line – Backup/redundant LGF equipment in on-line and operational.

3.3.2.3.17 Redundant Equipment Control

The MDT shall provide the capability to change the classification of the LGF equipment as indicated in Section 3.3.2.3.16.

3.3.2.3.18 Diagnostics Display

The MDT shall provide the capability to display diagnostic results following a failure or a manual initiation. On-screen help shall be provided in order to perform diagnostics and other maintenance related actions.

3.3.2.3.19 Diagnostics Control

The MDT shall provide the capability to manually initiate diagnostics. Manually initiated diagnostics shall include

a. Non-intrusive - Non-intrusive diagnostics do not affect the current LGF operation.
b. Intrusive - Intrusive diagnostics may affect the LGF operation or require a re-certification Flight Check.

3.3.2.3.20 Temperature Display

The MDT shall provide the capability to display the temperature inside and outside of the LGF equipment facility.

3.3.2.3.21 Adjustment Storage

Before log-off, MDT-entered settings and adjustment shall be confirmed and the values stored in LGF NVM.

3.3.2.4 Air Traffic Control Unit

A primary ATCU shall be provided as an external interface for installation in control towers and terminal and en route radar facilities at locations up to 50 miles from the airport. The ATCU shall be capable of working with up to 10 secondary ATCUs that are located between 15 feet and 5 miles of the primary ATCU.

3.3.2.4.1 ATCU - Approach Control

The ATCU shall include the capability to simultaneously enable all approaches associated with each runway end served by the LGF. The ATCU shall include the capability to simultaneously disable all approaches associated with each runway end served by the LGF. This capability will enable or disable all approaches to a runway end with a single action.

3.3.2.4.2 ATCU – Operational Status Display

The ATCU shall simultaneously display the operational status for up to 16 runway ends. This shall include notice that the runway end is either enabled, disabled, or LNAV Only. "LNAV Only" shall be displayed when the vertical guidance for a runway end is disabled.

3.3.2.4.3 ATCU - Modes

The ATCU shall display "Category 1," corresponding to the Normal Mode defined in Section 3.1.4.3. The ATCU shall display "Not Available," corresponding to the Not Available Mode defined in Section 3.1.4.4 or when in the Off State. The ATCU shall display changes in modes within 3 seconds of detection by the LGF.

3.3.2.4.4 ATCU - Maintenance Display

When the LGF is in the Test Mode, the ATCU shall simultaneously display "Test" and "Not Available." No other display lights shall be illuminated.

3.3.2.4.5 ATCU Alert Display

The ATCU shall display a constellation alert within 3 seconds from the time of prediction. The ATCU shall display the start time and the end time of the predicted outage.

3.3.2.4.6 Aural Signal

The ATCU shall initiate an aural signal for all LGF mode changes. The ATCU shall initiate an aural signal for all constellation alerts.

3.3.2.4.6.1 Audio Control

The ATCU shall provide the capability to manually control an aural signal with a range from low but not silenced to audible over ambient noise levels. The ATCU shall provide for a switch that acknowledges and silences the aural signal until reset or another event occurs.

3.3.2.4.7 Design Requirements

The ATCU design shall provide for transfer and lockout control between the primary ATCU and the secondary ATCUs. The ATCU shall be configurable to lock out control functions and provide status display only. The ATCU shall provide visual and aural annunciation for changes and updates of LGF status information.

3.3.2.4.7.1 Monitor Design Requirements

The ATCU monitor shall be designed to the following requirements:

a. Configurable for the following physical environments, including:

   1. rack-mounted in standard 19" equipment racks,

2. flush-mounted into the control tower console, Terminal Radar Approach CONtrol (TRACON), and Air Route Traffic Control Center (ARTCC), and
3. set-up as an independent workstation.

b. Display screen attributes:

1. 14" color flat screen LCD,
2. a resolution of at least 800 x 600 pixels and 72 Dots Per Inch (dpi),
3. refresh rate of more than 70 Hz,
4. viewing angle at least 160° in vertical and horizontal planes,
5. equipped with a touch screen input,
6. visible under all control tower lighting conditions, including direct sunlight and night operations,
7. luminescence rating ranging from ≥ 40 nits to ≤ 900 nits, and
8. anti-glare treatment that does not reduce available light to less than 800 nits at the highest brightness setting.

c. External components and controls, including

1. speaker,
2. volume control, and
3. brightness control.

The luminescence rating for the ATCU monitor shall be verified under actual operating conditions.

The ATCU monitor shall default to a standard resolution of not less than 800 x 600 pixels in the event of a power failure. The ATCU monitor shall store the last used resolution internally. The ATCU monitor shall store configuration and calibration settings for resolution when the LGF performs a cold boot.

3.3.3 RECORDING

Filtering of repetitive events shall be permitted, with the most recent event logged with an indication of the start of the event. Commands to write over or delete any of the data sets in Sections 3.3.3.1, 3.3.3.2, 3.3.3.3, and 3.3.3.4 shall not be permitted. The LGF NVM used to store data shall be secure at all times from tampering and manipulation.

3.3.3.1 System Events

The LGF shall maintain a chronological record in NVM of the previous 90 days of date, time, inside and outside temperature, log-on, log-off, alert, service alert, constellation alert, and alarm events. The capability to display system events records shall be provided via an MDT.

3.3.3.2 Events Recording

The LGF shall utilize the data from the sigma monitor, Section 3.2.1.2.7.7.3, to provide an indication of the hourly, daily, monthly, and yearly characteristics of the error in the broadcast correction. The data shall be recorded in NVM and exportable to the MDT and displayed on control chart(s) that includes alerts, service alerts, alarms, and action lines.

3.3.3.3 VDB Recording

The LGF shall automatically record all data broadcast parameters for a period not less than 48 hours. This data shall be exportable via a standard, commercially available electronic media. One 48-hour block of data shall be stored in NVM concurrently while the current 48-hour block of data is being recorded. At the end of each 48-hour period, the data stored from the previous 48 hours can be deleted and replaced with the current block of data. Upon command from the MDT, the recording function shall be terminated for a period not to exceed 30 minutes. Four time windows for one, 24-hour period shall be selectable to capture any requested VDB field(s). This shall be programmable for up to one week prior, and shall not interfere with the other recording requirement.

3.3.3.4 Reference Receiver Data

The LGF shall automatically record RR data for all RRs for a period not less than 48 hours. This data shall be exportable via a standard, commercially available electronic media. One 48-hour block of data shall be stored in NVM concurrently while the current 48-hour block of data is being recorded. At the end of each 48-hour period, the data stored from the previous 48 hours can be deleted and replaced with the current block of data. Recorded RR data shall include at a minimum,

a. L1 carrier phase with a resolution of 0.01 cycles,

b. L1 C/A code pseudorange with a resolution of .01 meter or better, and

c. broadcast navigation data for all tracked GPS ranging sources.

Upon command from the MDT, the recording function shall be terminated for a period not to exceed 30 minutes.

3.3.4 INTERFACE REQUIREMENTS

3.3.4.1 LSP Interface

The vendor shall define all LSP data interface requirements. The LSP interface to the MDT shall conform to EIA/TIA-232-E, Interface Between Data Terminal Equipment and Data Communications Equipment Employing Serial Binary Data Interchange (Electronic Industries Association, July 1991).

3.3.4.2 RSP Interface

The vendor shall define all RSP data interface requirements. The RSP interface to the MDT shall conform to EIA/TIA-232-E.

3.3.4.3 MDT Interface

The MDT interface shall conform to EIA/TIA-232-E.

3.3.4.4 RMDT Interface

The RMDT interface shall conform to EIA/TIA-232-E.

3.3.4.5 ATCU Interface

The vendor shall define all ATCU and secondary ATCU interface requirements. The interface characteristics shall be commercially available and in accordance with ISO standards and recommendations.

4. VERIFICATION

4.1 TEST PROGRAM

The testing and test activities of inspection, analysis, and demonstration assure that LGF hardware, software, and system requirements have been fully satisfied in accordance with the Acquisition Management System Test & Evaluation Process Guidelines (FAA, July 1997). These guidelines minimize reliance on explicit policies defining the conduct of test and evaluation. Practical testing appropriate to each acquisition is strongly supported. The qualification requirement verification process specified herein is in accordance with the guidelines.

Operational Test (OT) shall be conducted in support of the acceptance of the LGF in accordance with the requirements of this specification and operational requirements of the LAAS RD. OT is normally conducted with contractor support at the designated FAA test facility; the FAA William J. Hughes Technical Center (WJHTC). Development Test (DT), Production Acceptance Test (PAT), and Site Acceptance Test (SAT) are performed at the contractor facility and should reference the Verification Requirements Test Matrix (VRTM) in Appendix C.

For a non-government acquisition, certification is normally granted through a Type Acceptance program. Type Acceptance and OT may be conducted concurrently. For a non-government acquisition, it is not mandatory to conduct OT at the FAA designated facility. To support the FAA Government Industry Partnership (GIP), operational performance can be verified via government furnished aircraft and government furnished Time, Space, Position Information (TSPI) equipment. Raw data and results from the contractor and government could be pooled for analysis purposes.

4.1.1 GENERAL TESTING REQUIREMENTS

4.1.1.1 Development Test

DT activities shall be conducted to verify that the implemented hardware and software design meets the functional and performance requirements of the LGF specification. Specific tests for verification are not conveyed, but normally include the verification of software and hardware requirements, stability and dry running, and system level testing.

4.1.1.2 Production Acceptance Test

PAT shall be performed on each end-item before it leaves the factory to verify that the end-item conforms to applicable requirements, is free from manufacturing defects, and is substantially identical to the qualified system.

4.1.1.3 Site Acceptance Test

SAT is conducted after completion of hardware installation and checkout and the installation has been inspected and approved for workmanship and configuration. SAT is accomplished initially for the developmental system, and is repeated for each production system after PAT. Contractor-conducted testing shall be performed at each field site to verify that the new system is installed and operating properly on site.

4.1.1.4 Verification Methods

The LGF Test Program shall use the verification methods of Demonstration (D), Inspection (I), Analysis (A), and Test (T). These methods are defined as follows:

a. D – Demonstration is a method of verification where qualitative versus quantitative validation of a requirement is made during a dynamic test of the equipment. Demonstration activities are further characterized by the following:

   1. If a requirement is validated by test during first article qualification testing and the requirement has enough significance that it is re-tested during acceptance test, then this acceptance testing can be indicated in the VRTM as a Demonstration.

   2. Software functional requirements are validated by demonstration since the functionality must be observed through secondary media.

b. I – Inspection is a method of verification to determine compliance with specification requirements and consist primarily of visual observations, mechanical measurements of the equipment, physical locations, and technical examination of engineering-supported documentation.

c. A – Analysis is a method of verification that consists of comparing hardware or software design with known scientific and technical principles, technical data, or procedures and practices to validate that the proposed design will meet the specified functional and performance requirements. Analysis also includes the use of modeling and simulation.

d. T – Test is a method of verification that will measure equipment performance under specific configuration-load conditions and after the controlled application of known stimuli. Quantitative values are measured, compared against previous predicted success criteria, and evaluated to determine the degree of compliance.

Appendix A
Interference Environment

The interference environment shall be consistent with the following figures and tables (Figure H-1 of the MASPS, Figure H-2 of the MASPS, and Tables H-1 and H-2 of the MASPS). Reference Receivers shall meet the performance requirements of this specification when operated within the specified operating environment, given ranging signal levels of –130 dBm for the GPS satellite signals, –131 dBm for SBAS satellite signals, and as defined in Appendix D of RTCA DO-246A for Airport Pseudolites (APLs).

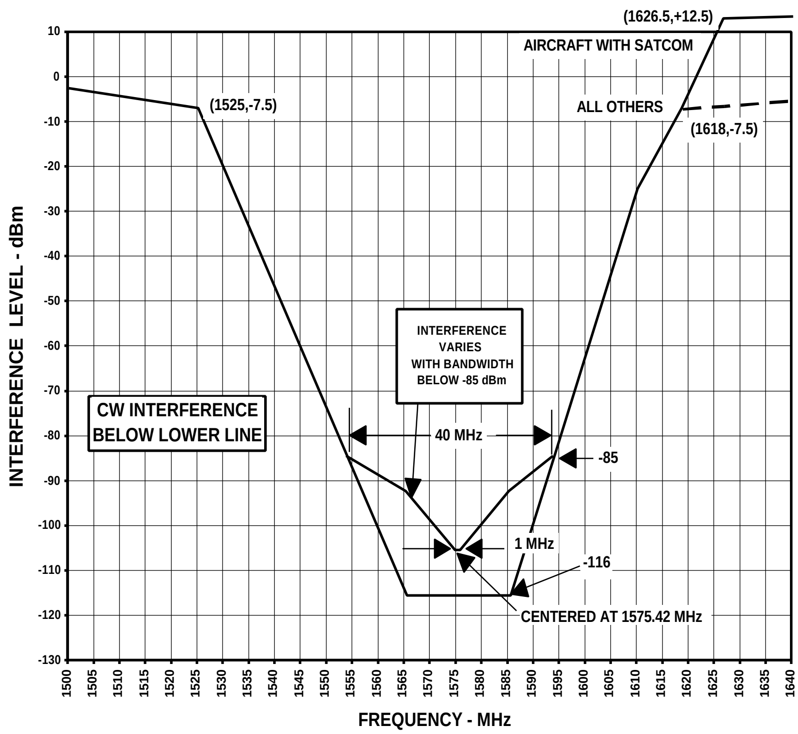

Figure A-1. H-1 (MASPS) Interference Levels At Output Of Idealized 0 Dbi Antenna

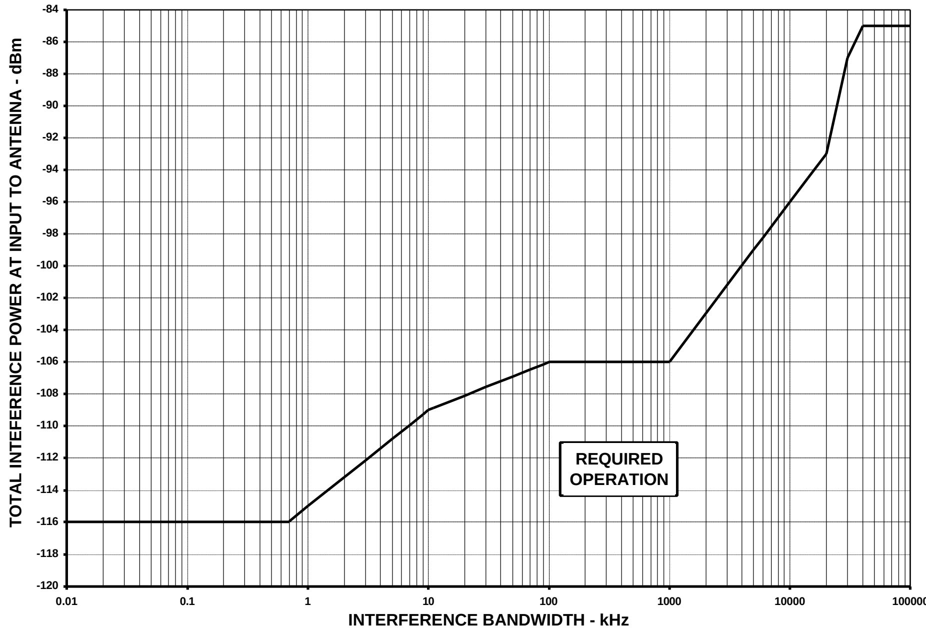

Figure A-2. H-2 (MASPS) In-Band and Near-Band Interference Environments

Table A-1. H-1 (MASPS) Out-of-Band Pulse Interference

	GPS/SBAS/APL	GPS/APL Only
Peak Power	+30 dBm	+30 dBm
Pulse Width	125 μsec	1 ms
Pulse Duty Cycle	10%	10%

Table A-2. H-2 (MASPS) In-Band And Near-Band Interference Bandwidth Definitions

BANDWIDTH	INTERFERENCE LEVEL
$0 \le BW_I \le 700$ Hz	-116 dBm
700 Hz $< BW_I \le$ 10 kHz	$-115 + 6 \log_{10}(BW_I/1000)$ dBm
10 kHz $< BW_I \le$ 100 kHz	$-109 + 3 \log_{10}(BW_I/10000)$ dBm
100 kHz $< BW_I \le$ 1 MHz	-106 dBm
1 MHz $< BW_I \le$ 20 MHz	Linearly increasing from -106 to -93 dBm*
20 MHz $< BW_I \le$ 30 MHz	Linearly increasing from -93 to -87 dBm*
30 MHz $< BW_I \le$ 40 MHz	Linearly increasing from -87 to -85 dBm*
40 MHz $< BW_I$	-85 dBm*

*Interference levels will not exceed -106 dBm/MHz in the frequency range of 1575.42 ± 10 MHz.

Appendix B
Configuration Management and Quality Control

B – 1. Configuration Management

Configuration Management for the FAA is implemented in accordance with MIL-HDBK-61 and EIA-649. FAA CM includes, but is not limited to, the following:

a. Configuration Control Board
Configuration Control Boards (CCB) are established to evaluate all proposed changes to a CI. The CCB also advises the CCB Chair on disposition of a change.

b. Configuration Identification
Configuration identification includes the selection, description, and naming of the physical and functional characteristics of a system. Configuration Items (CI) are those specification items whose functions and performance parameters must be defined and controlled to achieve the overall end use function and performance.

c. Configuration Control
Configuration control is implemented to manage changes to the established and agreed upon baseline of all identified CIs. Any proposed change to a CI must go through a formal evaluation and approval process. Configuration control processes also maintain interfaces and support interoperability.

d. CM Audits
Configuration audits are conducted to verify accomplishment of development requirements and achievement of a product through examination of the technical documentation. An audit validates traceability of baseline changes from source to object, source to listing, source to documentation, and source to requirement. Audits also validate incorporation of approval changes and provide integrity for baselines.

e. Configuration Status Accounting
Configuration status accounting activities are conducted to record and report information necessary to manage CIs. Records and reports include records of approved configuration documentation and CI numbers; reports on the status of proposed changes, deviations and waivers; and reports on the implementation status of approved changes.

B – 2. Quality Control

A Quality Control Program Plan for the LGF is also developed. This plan should include procedures for monitoring and evaluating the processes of configuration management, facilities management, and system verification. Procedures for evaluating the systems for controlling Government Furnished Equipment (GFE), NDI, and Commercial off-the-Shelf (COTS) equipment are provided.

F

Appendix C
Verification Requirements Traceability Matrix

					Verification Level and Method			
Paragraph				**Requirement**	**DT**	**PAT**	**SAT**	
3.1				LAAS Ground Facility General Requirements				Title
3.1.1				Coverage Volume				Definition
3.1.1.1				Approach Coverage Volume	T, A		T	
3.1.1.2				VDB Coverage Volume	T, A	T	T	For DT - a over frequ temperatu Analysis c propagatic assumptio
3.1.2				Integrity				Title
3.1.2.1				Integrity of Ranging Sources	A			
3.1.2.2				Integrity of the Ground Facility	A			
3.1.2.3				Integrity of a Single RR	A			
3.1.2.4				Latent Failures	A			
3.1.3				Continuity				Title
3.1.3.1				VHF Data Broadcasting Transmission Continuity	A, T			

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	
3.1.3.2				RR and Ground Integrity Monitoring Continuity	A, T			
3.1.3.3				Latent Failures Affecting Continuity	A, T			
3.1.4				States and Modes				Title
3.1.4.1				States	D	D	D	
	a			LGF On	D	D	D	
	b			LGF Off	D	D	D	
3.1.4.2				Modes	D	D	D	
	a			Normal	D	D	D	
	b			Not Available	D	D	D	
	c			Test	D	D	D	
3.1.4.3				Normal Mode	D	D	D	
	a			Conditions	D	D	D	
		1		Alert	D	D	D	
		2		Service Alert	D	D	D	
		3		Constellation Alert	D	D	D	
	b			Actions	D	D	D	
		1		Approach Control	D	D	D	

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	
		2		Periodic Maintenance	D	D	D	
		3		Non-Intrusive Diagnostics	D	D	D	
		4		LRU Replacement	D	D	D	
		5		Data Recording	D	D	D	
		6		Status Monitoring	D	D	D	
		7		User ID and Password Change	D	D	D	
		8		Adjustment Storage	D	D	D	
		9		Fault Recovery	D	D	D	
	c			Transition criteria				Title
		1		Entering Normal Mode	D	D	D	
			a	From Off State	D	D	D	
			b	From Test Mode	D	D	D	
			c	From Not Available Mode	D	D	D	
		2		Exiting Normal Mode	D	D	D	
			a	To Not Available Mode	D	D	D	
			b	To Test Mode	D	D	D	

F

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	
3.1.4.4				Not Available Mode	D	D	D	
	a			Condition	D	D	D	
		1		Alarm	D	D	D	
	b			Actions	D	D	D	
		1		Automatic restart	D	D	D	
		2		States and modes display	D	D	D	
		3		System power display	D	D	D	
		4		System events recording	D	D	D	
	c			Transition criteria				Title
		1		Entering Not Available Mode	D	D	D	
			a	From Normal Mode	D	D	D	
			b	From Test Mode	D	D	D	
		2		Exiting Not Available Mode	D	D	D	
			a	To Normal Mode	D	D	D	
			b	To Test Mode	D	D	D	
3.1.4.5				Test Mode	D	D	D	
	a			Conditions				

					Verification Level and Method		
Paragraph				Requirement	DT	PAT	SAT
		1		Alert	D	D	D
		2		Service Alert	D	D	D
		3		Constellation Alert	D	D	D
		4		Alarm	D	D	D
	b			Maintenance and Test Actions			
		1		Restart the LGF	D	D	D
		2		Intrusive and non-intrusive diagnostics	D	D	D
		3		Trouble shooting	D	D	D
		4		Site specific parameter change	D	D	D
		5		Alerts and alarms threshold change	D	D	D
		6		Redundant equipment status change	D	D	D
		7		Monitor bypass	D	D	D
		8		VDB bypass	D	D	D
		9		Approach Control	D	D	D
		10		Periodic Maintenance	D	D	D
		11		LRU Replacement	D	D	D
		12		Data Recording	D	D	D

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	
		13		Status Monitoring	D	D	D	
		14		User ID and Password Change	D	D	D	
		15		Adjustment Storage	D	D	D	
		16		Fault Recovery	D	D	D	
	c			Transition criteria				
		1		Entering Test Mode	D	D	D	
			a	From Normal	D	D	D	
			b	From Not Available	D	D	D	
		2		Exiting Test Mode	D	D	D	
			a	To Normal	D	D	D	
			b	To Not Available	D	D	D	
3.1.5				Executive Monitoring				Title
3.1.5.1				Fault Monitoring	D			
				Table 3-1	D, A			
				Table 3-2	D, A			
3.1.5.1.1				Fault Recovery	D, A			
3.1.5.1.2				Generation of Alerts	D, A			

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	
3.1.5.1.3				Generation of Service Alerts				
3.1.5.1.3.1.				Continuity Faults	D, A			
3.1.5.1.3.2				Environmental Faults	D, A			
3.1.5.1.4				Generation of Constellation Alert	T, A			
3.1.5.1.5				Generation of Alarms	T			
	a			No measurement blocks	T			
	b			VDB terminated – integrity failure	T			
	c			VDB terminated – VDB failure	T			
3.1.5.1.5.1				Automatic Restart	T	T	T	
3.1.6				Software Design Assurance	I, T			
3.1.7				Complex Electronic Hardware Design Assurance	I			
3.2				Data Broadcast				Title
3.2.1				Broadcast Data Requirements	D, I	D	D	
3.2.1.1				LAAS Message Block	I			
3.2.1.1.1				Message Block Header				Title
3.2.1.1.1.1				Message Block Identifier	T			
3.2.1.1.1.2				Ground Station Identification	T			

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	
3.2.1.1.1.3				Message Type Identifier	T			
3.2.1.1.1.4				Message Length	T			
3.2.1.1.2				Message	T			
3.2.1.1.3				Cyclic Redundancy Check	T			
3.2.1.2				Type 1 Message – Differential Corrections	T	T	T	
3.2.1.2.1				Modified Z-Count	T			
3.2.1.2.2				Additional Message Flag	T			
3.2.1.2.3				Number of Measurements	T	T	T	
3.2.1.2.4				Measurement Type	T	T		
3.2.1.2.5				Ephemeris Cyclic Redundancy Check	T	T		
3.2.1.2.6				Source Availability Duration	T	T		
3.2.1.2.6.1				Reception Mask	T	T	T	
3.2.1.2.7				Ranging Source Measurement Block	T	T		
3.2.1.2.7.1				Ranging Source Identification	T	T		
3.2.1.2.7.2				Ranging Signal Sources				Title
	a			GPS SPS signals	T	T		
	b			SBAS signals	T	T		

Paragraph				Requirement	Verification Level and Method			
					DT	PAT	SAT	
3.2.1.2.7.3				Conditions for Transmitting the Ranging Source Measurement Block				Title
3.2.1.2.7.3.1				Valid GPS Ranging Sources	T,A			
	a			signal deformation;	T,A			
	b			RF Interference (RFI) in excess of levels defined in Appendix A;	T,A			
	c			signal levels below those specified in the GPS SPS Signal Spec	T,A			
	d			Code/carrier divergence;	T,A			
	e			Excessive acceleration	T,A			
3.2.1.2.7.3.2				Valid SBAS Ranging Sources	T,A			
	a			RFI in excess of levels defined in Appendix A;	T,A			
	b			signal levels below WAAS Specification FAA-E-2892B	T,A			
	c			Code/carrier divergence;	T,A			
	d			Excessive acceleration	T,A			
3.2.1.2.7.3.3				Valid GPS Navigation Data	T			
	a			Three or more parity errors	T			

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	
	b			IODE does not match IODC	T			
	c			HOW set to one	T			
	d			All data bits are zeros in subframes 1, 2 or 3	T			
	e			Default navigation data transmitted	T			
	f			Preamble does not equal 8B	T			
	g			All RRs have not decoded same ephemeris	T			
	h			Broadcast ephemeris orbit more than 7000 m from almanac orbit	T			
	i			Pseudorange correction or rate exceeded	T			
	j			“Do not use” message from SBAS	T			
	k			Ephemeris CRC changes, IODE doesn't	T			
	l			Decoded PRN is 37	T			
	m			Satellite indicated as unhealthy	T			
3.2.1.2.7.3.4				Valid SBAS Navigation Messages				Title
	a			three or more parity errors	T			
	b			all RRs not decoded the same ephemeris and clock data;	T			

Paragraph				Requirement	Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	
	c			Broadcast ephemeris orbit more than 200 km from almanac orbit	T			
	d			Differences in position greater than 0.12 m in last 4 minutes	T			
	e			More than 4 minutes elapsed since last SBAS navigation message	T			
	f			Pseudorange correction or rate exceeded	T			
	g			“Do not use” message from SBAS	T			
3.2.1.2.7.4				Issue of Data	T			
3.2.1.2.7.5				Pseudorange Corrections	D			
3.2.1.2.7.5.1				Smoothed Pseudorange				Title
				Calculated in accordance with equation 7	A,I			
	a			Correlator spacing 0.1 chip	A,T			
	b			Tracking loop bandwidth > 0.125 Hz	A,T			
	c			Strongest peak tracked	A,T			
3.2.1.2.7.5.2				GPS Predicted Range	T,I			
3.2.1.2.7.5.3				SBAS Predicted Range	T,I			
3.2.1.2.7.5.4				GPS Smoothed Pseudorange Correction	T,I			

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	
3.2.1.2.7.5.5				SBAS Smoothed Pseudorange Correction	T,I			
3.2.1.2.7.5.6				Broadcast Correction	T,I			
				Calculated according to equations 10 and 11	A, I			
	a			If Nc is less than four, no corrections provided	T			
	b			M shall be at least 3 for the fault free configuration.	I	I	I	
	c			Each RR measurement (m,n) updated at 2 Hz rate.	T	T		
	d			Each RR measurement (m,n) shall be identical signal processing.	A,I	I		
3.2.1.2.7.5.6.1				Correction Errors				Title
	a			more than 200 seconds have expired since initialization	T			
	b			the magnitude of the associated B-values within tolerance for GPS	T			
	c			the magnitude of the associated B-values within tolerance for SBAS	T			
	d			the magnitude of the pseudorange correction does not exceed 327.67 m	T			

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	
3.2.1.2.7.6				Pseudorange Correction Rate	T			
3.2.1.2.7.6.1				Condition for Valid Pseudorange Correction Rate	T			
	a			Pseudorange correction rate does not exceed +/-3.4 m/s	T			
	b			Standard deviation does not exceed 4.0 cm per second	T			
3.2.1.2.7.6.1.1				Pseudorange correction rate monitor	T			
3.2.1.2.7.7				Sigma Pseudorange Ground	A,T			
	a			VPL_{H0} and LPL_{H0} bound user error	A,T		T	
	b			VPL_{H1} and LPL_{H1} bound user error	A,T		T	
3.2.1.2.7.7.1				GPS Sigma Pseudorange Accuracy	A,T		T	DT over t
3.2.1.2.7.7.2				SBAS Sigma Pseudorange Accuracy	A,T		T	DT over t
3.2.1.2.7.7.3				Condition for Valid Sigma Pseudorange Ground	A,D			
3.2.1.2.7.8				B-Values	T	D	D	
3.2.1.3				Type 2 Message – Differential Reference point	T	T	T	

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	
3.2.1.3.1				Ground Station Installed Receivers	T	D	D	
3.2.1.3.2				Ground Station Accuracy Designator	T	D	D	
3.2.1.3.3				Continuity and Integrity Designator	T	D	D	
3.2.1.3.4				Local Magnetic Variation	T	D	D	
3.2.1.3.5				Refractivity Index	T	D	D	
3.2.1.3.6				Scale Height	T	D	D	
3.2.1.3.7				Refractivity Uncertainty	T	D	D	
3.2.1.3.8				Latitude	T	D	D	
3.2.1.3.9				Longitude	T	D	D	
3.2.1.3.10				Reference Point Height	T	D	D	
3.2.1.3.11				Sigma Ionosphere	T	D	D	
3.2.1.4				Type 4 Message – FAS Data	T	D	D	
3.2.1.4.1				Data Set Length	T	D	D	
3.2.1.4.2				FAS Data Block	T	D	D	
3.2.1.4.2.1				Operation Type	T	D	D	
3.2.1.4.2.2				SBAS Provider Identification	T	D	D	
3.2.1.4.2.3				Airport Identification	T	D	D	

					Verification Level and Method			
Paragraph				**Requirement**	**DT**	**PAT**	**SAT**	
3.2.1.4.2.4				Runway Number	T	D	D	
3.2.1.4.2.5				Runway Letter	T	D	D	
3.2.1.4.2.6				Approach Performance Designator	T	D	D	
3.2.1.4.2.7				Route Indicator	T	D	D	
3.2.1.4.2.8				Reference Path Data Selector	T	D	D	
3.2.1.4.2.9				Reference Path Identifier	T	D	D	
3.2.1.4.2.10				LTP/FTP Latitude	T	D	D	
3.2.1.4.2.11				LTP/FTP Longitude	T	D	D	
3.2.1.4.2.12				LTP/FTP Height	T	D	D	
3.2.1.4.2.13				Delta FPAP Latitude	T	D	D	
3.2.1.4.2.14				Delta FPAP Longitude	T	D	D	
3.2.1.4.2.15				Approach Threshold Crossing Height	T	D	D	
3.2.1.4.2.16				Approach TCH Units Selector	T	D	D	
3.2.1.4.2.17				Glidepath Angle	T	D	D	
3.2.1.4.2.18				Course Width	T	D	D	
3.2.1.4.2.19				Delta Length Offset	T	D	D	
3.2.1.4.2.20				FAS CRC	T	D	D	

F

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	
3.2.1.4.3				FAS VAL/App status	T	D	D	
3.2.1.4.4				FAS LAL/App status	T	D	D	
3.2.2				RF Transmission Characteristics				Title
3.2.2.1				Symbol Rate	T			
3.2.2.2				Emission Designator	I			
3.2.2.3				Antenna Polarization	T			
3.2.2.4				Field Strength	T			Test over humidity
3.2.2.4.1				Measured field strength	T			
				Horizontal minimum 215 μV/m	T			
				Horizontal maximum 350 V/m	T			
				Vertical minimum 136 μV/m	T			
				Vertical maximum 221 V/m	T			
3.2.2.4.2				Phase offset	T			
3.2.2.5				Spectral Characteristics				Title
3.2.2.5.1				Carrier Frequencies	T	T		DT over f
3.2.2.5.2				Unwanted Emissions	T			Test over
3.2.2.6				Adjacent Channel Emissions	T			Test over

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	
3.2.2.6.1				Adjacent Temporal Interference	T			Test over
3.2.2.6.2				Frequency Stability	T			Test over
3.2.2.7				Modulation	T,I			
3.2.2.7.1				Pulse Shaping Filters	T,I			
3.2.2.7.2				Error Vector Magnitude	T,I			
3.2.2.8				Burst Data Content	T,I			
3.2.2.9				Broadcast Timing Structure Division Multiple Access	T,I			
3.2.2.10				Message Format	T,I			
3.2.3				RF Broadcast Monitoring				Title
	a			Disagreement between transmitted and stored data for 3 seconds	T	D		
	b			Change in transmitted power by 3 dB	T	D		
	c			More than 0.2% of messages not transmitted	T	D		
	d			No transmission for 3 seconds	T	D		
	e			Data out of TDMA slot for 3 seconds	T	D		
3.3				Operation and Maintenance	I			

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	
3.3.1				System Requirements				Title
3.3.1.1				Environmental Design Values	T			
3.3.1.1.1				Environmental Service Conditions	T			
3.3.1.1.2				Wind and Ice Loading	T			
3.3.1.1.3				Non-Operating Conditions	T			
3.3.1.2				Primary Power	T	T		
3.3.1.3				Supplementary Power	T	T	D	
3.3.1.3.1				Power Supply	T	D	D	
3.3.1.4				Environmental Sensors				Title
	a			intrusion detector sensor,	I	I	I	
	b			smoke detector sensor,	I	I	I	
	c			obstruction lights sensor,	I	I	I	
	d			AC power sensor,	I	I	I	
	e			inside temperature sensor,	I	I	I	
	f			outside temperature sensor.	I	I	I	
3.3.1.4.1				Intrusion Detector	T			
3.3.1.4.2				Smoke Detector	T			

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	
3.3.1.4.3				Obstruction Lights	T			
3.3.1.4.4				Alternate Current Power	T			
3.3.1.4.5				Inside Temperature	T			
3.3.1.4.6				Outside Temperature	T			
3.3.1.5				Fault Diagnostics	D	D	D	
	a			automatic diagnostics when alarm occurs.	D	D	D	Test samp
	b			Fault isolation 90% to group of three LRUs or less using automatic diagnostics.	T	D	D	
	c			Manual isolation to a single LRU - 100%	D			
3.3.1.6				Maintainability of Electronic Equipment				Title
3.3.1.6.1				Maintenance Concept	I			
3.3.1.6.2				Unscheduled Maintenance				Title
3.3.1.6.2.1				Reliability	A			
3.3.1.6.2.2				Maintainability	A			
	a			diagnostic time,	T			Test samp
	b			removal of the failed LRU,	T			
	c			replacement of the new LRU,	T			
	d			initialization of the new LRU,	T			

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	
	e			all adjustments required to return the LGF to normal operation.	T			
3.3.1.6.3				Periodic Maintenance	D,A			Demonstr
3.3.1.6.4				System specialist workload	D,A			
3.3.1.7				Security	D			
3.3.1.7.1				System Identifiers and Authenticators	D			
3.3.1.7.1.1				Security Levels	D		D	
3.3.1.7.1.2				Read Access	D		D	
3.3.1.7.1.3				Write Access	D		D	
3.3.1.7.1.3.1				Write Access-LSP	D		D	
3.3.1.7.1.3.2				Write Access-RSP	D		D	
3.3.1.7.2				User Identifications and Passwords	D,I			
3.3.1.7.2.1				Logical Access Control	D,I			
3.3.1.7.3				Invalid User Identification or Password Entry				Title
	a			an error message to be output to the MDT,	D			
	b			the security level access procedure to be terminated after 3 invalid entries	D			

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	
	c			the LGF security process to return to an idle state.	D			
	d			Access inhibited for 15 min. after 3 invalid entries	D			
3.3.1.7.4				Log-on Time-out	D			
3.3.1.8				Physical Design and Packaging	A,I			
3.3.1.8.1				Obstruction Lights	I			
3.3.1.9				Electrical				Title
3.3.1.9.1				Electrical Wiring	I			
3.3.1.9.1.1				External Wiring	I			
3.3.1.9.2				Alternating Current Line Controls	I			
3.3.1.9.3				Main Power Switch	I			
3.3.1.9.4				AC Line-Input Resistance to Ground	I			

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	
3.3.1.9.5				AC Line Connectors and Power Cord	I			
3.3.1.9.6				Alternating Current Line Controls	I			
3.3.1.9.7				Transformer Isolation, Direct Current Power Supplies	I			
3.3.1.9.8				Voltage Regulators	I			
3.3.1.9.9				Convenience Outlets	I			
3.3.1.9.10				Circuit Protection	I			
3.3.1.9.11				Electrical Overload Protection	I			
3.3.1.9.11.1				Current Overload Protection	I			
3.3.1.9.11.2				Protective Devices	I			
3.3.1.9.12				Circuit Breakers	I			
3.3.1.9.12.1				Short Circuit Coordination	I			
3.3.1.9.12.2				Normal Performance	I			
3.3.1.9.13				Test Points and Test Equipment	I			
3.3.1.9.13.1				Built in Test Device Requirements	I			
3.3.1.9.13.2				Location of Test Points and Adjustment Controls	I			
3.3.1.9.13.3				Test Point Circuitry Protection	I			

					Verification Level and Method			
Paragraph				**Requirement**	**DT**	**PAT**	**SAT**	
3.3.1.9.13.4				Failure	I			
3.3.1.9.14				Electrical Breakdown Prevention	I			
3.3.1.9.15				Grounding, Bonding, Shielding, and Transient Protection	I			
3.3.1.9.16				Obstruction Lights	I			
3.3.1.9.17				Power Factor	I			
3.3.1.9.18				Peak Inrush Current	I			
3.3.1.10				Markings	I			
3.3.1.10.1				RF Connectors	I			
3.3.1.10.2				Fuse Markings	I			
3.3.1.10.3				Terminal Strips and Blocks	I			
3.3.1.10.4				Controls and Indicating Devices	I			
3.3.1.10.5				Nameplates	I			
3.3.1.10.6				Safety Related Markings	I			
3.3.1.10.6.1				Physical Hazards	I			
3.3.1.10.6.2				Center of Gravity	I			
3.3.1.10.7				Accident Prevention Signs and Labels	I			
3.3.1.10.8				Sign Design	I			

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	
3.3.1.10.9				Sign Classification and Detailed Design				Title
3.3.1.10.9.1				Class I - Danger Classification	I			
3.3.1.10.9.2				Class II - Caution Classification	I			
3.3.1.10.9.3				Class III - General Safety Classification	I			
3.3.1.10.9.4				Class IV - Fire and Emergency Classification	I			
3.3.1.11				Personnel Safety and Health	I			
3.3.1.11.1				Human Factors Engineering	A,I			
	a			Hazardous Components,	A,I			
	b			Safety-Related Interface Considerations	A,I			
	c			Environmental Constraints	A,I			
	d			Operating, Test, Maintenance, And Emergency Procedures,	A,I			
	e			Facilities And Support Equipment,	A,I			
	f			Safety Related Equipment, Safeguards	A,I			
3.3.1.11.2				Electrical Safety	I			
3.3.1.11.2.1				Ground Potential	I			
3.3.1.11.2.2				Hinged or Slide Mounted Panels and Doors	I			

F

					Verification Level and Method			
Paragraph				**Requirement**	**DT**	**PAT**	**SAT**	
3.3.1.11.2.3				Shielding	I			
3.3.1.11.2.4				RF Voltage Protection	I			
3.3.1.11.2.5				Electrical Connectors	I			
3.3.1.11.3				RF Limits				Title
3.3.1.11.3.1				Applicability of Federal Standards	A,I			
3.3.1.11.3.2				Radiation Hazards and Protection	A,I			
3.3.1.11.4				Cathode Ray Tubes	A,I			
3.3.1.12				Hazardous and Restricted Materials	A,I			
3.3.1.13				FCC Type Acceptance and Registration	T			
3.3.2				Control and Display	A,I			
3.3.2.1				Local Status Panel	I			
3.3.2.1.1				LSP – Modes and Service Alerts	T	T	D	
3.3.2.1.1.1				LSP - Initialization	T	T	D	
3.3.2.1.2				LSP – Aural Signal	D	D	D	

Paragraph				Requirement	Verification Level and Method			
					DT	PAT	SAT	
3.3.2.1.3				LSP – Mute Switch	D	D	D	
3.3.2.2				Remote Status Panel	I			
3.3.2.2.1				RSP – Modes and Service Alerts	T	T	D	
3.3.2.2.1.1				RSP - Initialization	T	T	D	
3.3.2.2.2				RSP - Aural Signal	D	D	D	
3.3.2.2.3				RSP - Mute Switch	D	D	D	
3.3.2.2.4				RSP - Supplementary Power	D,A	D	D	
3.3.2.3				Maintenance Data Terminal	I			
3.3.2.3.1				MDT Control and Display	D	D	D	
3.3.2.3.1.1				Restart	D	D	D	
3.3.2.3.2				States and Modes Display	D	D	D	
3.3.2.3.3				Alerts and Alarm Display	T	T	D	
3.3.2.3.4				VDB Display	D	D	D	
3.3.2.3.5				VDB Control	D	D	D	
3.3.2.3.6				VDB Message Data	D	D	D	
	a			Message Header	D	D	D	
		1		Reference Station ID	D	D	D	

					Verification Level and Method			
Paragraph				**Requirement**	**DT**	**PAT**	**SAT**	
	b			Type 1 Message	D	D	D	
		1		Measurement Type	D	D	D	
		2		Sigma Pseudorange Ground	D	D	D	
	c			Type 2 Message	D	D	D	
		1		LGF Installed RRs	D	D	D	
		2		LGF Accuracy Designator	D	D	D	
		3		Local Magnetic Variation	D	D	D	
		4		Refractivity Index	D	D	D	
		5		Scale Height	D	D	D	
		6		Refractivity Uncertainty	D	D	D	
		7		Latitude	D	D	D	
		8		Longitude	D	D	D	
		9		Vertical Ellipsoid Offset	D	D	D	
	d			Type 4 Message	D	D	D	
		1		Data Set Length	D	D	D	
		2		FAS Data Block - manually entered as a block	D	D	D	
			a	Operation Type	D	D	D	

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	
			b	SBAS Provider Identification	D	D	D	
			c	Airport Identification	D	D	D	
			d	Runway Number	D	D	D	
			e	Runway Letter	D	D	D	
			f	Approach Performance Designator	D	D	D	
			g	Route Indicator	D	D	D	
			h	Performance Path Data Selector	D	D	D	
			i	Reference Path Identifier	D	D	D	
			j	LTP/FTP Latitude	D	D	D	
			k	LTP/FTP Longitude	D	D	D	
			l	LTP/FTP Height	D	D	D	
			m	Delta FPAP Latitude	D	D	D	
			n	Delta FPAP Longitude	D	D	D	
			o	Approach TCH	D	D	D	
			p	Approach TCH Units Selector	D	D	D	
			q	GPA	D	D	D	
			r	Course Width	D	D	D	

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	
			s	Delta Length Offset	D	D	D	
			t	FAS CRC	D	D	D	
		3		FAS VAL/Approach Status	D	D	D	
		4		FAS LAL/Approach Status	D	D	D	
3.3.2.3.7				System Power Display	D	D	D	
3.3.2.3.8				Alerts and Alarm Status Display	D	D	D	
3.3.2.3.9				Alerts and Alarm Threshold Display	D	D	D	
3.3.2.3.10				Alerts and Alarm Threshold Control	D	D	D	
3.3.2.3.11				Monitor By-pass				Title
3.3.2.3.11.1				By-pass annunciation	D	D	D	
3.3.2.3.11.2				By-pass actions	D	D	D	
3.3.2.3.12				Static Site Data Display	D	D	D	
	a			VDB Frequency	D	D	D	
	b			VDB Power	D	D	D	
	c			TDM Time Slot(s)	D	D	D	
	d			RR Geodetic Coordinates	D	D	D	
	e			Reception Mask	D	D	D	

F

					Verification Level and Method			
Paragraph				**Requirement**	**DT**	**PAT**	**SAT**	
	f			Sigma$_{rrc}$ (one sigma range rate correction error)	D	D	D	
3.3.2.3.13				Static Site Data Control	D	D	D	
	a			VDB Frequency	T	D	D	
	b			VDB Power	T	D	D	
	c			TDM Time Slot(s)	T	D	D	
	d			RR Geodetic Coordinates	D	D	D	
	e			Reception Mask	D	D	D	
	f			Sigma$_{rrc}$ (one sigma range rate correction error)	D	D	D	
3.3.2.3.14				Approach Status Display	D	D	D	
3.3.2.3.15				Approach Control	D	D	D	
3.3.2.3.16				Redundant Equipment Status Display	D	D	D	
	a			Main - Primary LGF Equipment	D	D	D	
		1		On-line	D	D	D	
		2		Failed	D	D	D	
		3		Disabled	D	D	D	

					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	
	b			Standby - Backup/redundant LGF Equipment	D	D	D	
		1		Available	D	D	D	
		2		Failed	D	D	D	
		3		Disabled	D	D	D	
		4		On-line	D	D	D	
3.3.2.3.17				Redundant Equipment Control	D	D	D	
3.3.2.3.18				Diagnostics Display	D	D	D	
3.3.2.3.19				Diagnostics Control	D	D	D	
	a			Non-intrusive - LGF remains in Operational Mode	D	D	D	
	b			Intrusive - LGF is in Maintenance Mode.	D	D	D	
3.3.2.3.20				Temperature Display	D	D	D	
3.3.2.3.21				Adjustment Storage	A,I			
3.3.2.4				Remote Maintenance Interface	D,I	I	I	
3.3.2.5				ATCU	I			
3.3.2.5.1				ATCU - Approach Control	D	D	D	
3.3.2.5.2				ATCU – Operational Status Display	D	D	D	

F

					Verification Level and Method			
Paragraph				**Requirement**	**DT**	**PAT**	**SAT**	
3.3.2.5.3				ATCU - Modes	D	D	D	
3.3.2.5.4				ATCU - Maintenance Display	D	D	D	
3.3.2.5.5				ATCU – Constellation Alert Display				
3.3.2.5.6				Aural Signal	D	D	D	
3.3.2.5.6.1				Audio Control	D	D	D	
3.3.2.5.7				Design Requirements	I,A			
3.3.2.5.7.1				Monitor Design Requirements				
	a			Configurable				
		1		Rack Mounted in Standard 19" Rack	I	I	I	
		2		Flush Mounted	I	I	I	
		3		Independent Workstation	I	I	I	
	b			Display Screen Attributes				
		1		14" Flat Color Screen LCD	I	I	I	
		2		Resolution of 800x600 and 72 dpi	I	I	I	
		3		Refresh Rate of Greater Than 70 Hz	I	I	I	
		4		160° Viewing Angle, Horz. and Vert.	D	D	D	
		5		Touch Screen	D	D	D	

					Verification Level and Method			
Paragraph				**Requirement**	**DT**	**PAT**	**SAT**	
		6		Visible Under all Lighting Conditions	D	D	D	
		7		Luminescence from 40 to 900 nits	I	I	I	
		8		Anit-glare does not Reduce Light to less than 800 nits	D	D	D	
	c			External Components and Controls				
		1		Speaker	D	D	D	
		2		Volume Control	D	D	D	
		3		Brightness Control	D	D	D	
3.3.3				Recording	D	D	D	
3.3.3.1				System Events	D	D	D	
3.3.3.2				Events Recording	D	D	D	
3.3.3.3				VDB Recording	D	D	D	
3.3.3.4				Reference Receiver Data	D	D	D	
3.3.4				Interface Requirements				Title
3.3.4.1				LSP Interface	I			
3.3.4.2				RSP Interface	I			
3.3.4.3				MDT Interface	I			
3.3.4.4				RMDT Interface	I			

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					Verification Level and Method			
Paragraph				Requirement	DT	PAT	SAT	
3.3.4.5				ATCU Interface	I			
4				Verification				Title
4.1				Test Program	I			
4.1.1				General Testing Requirements				Title
4.1.1.1				Development Test	I			
4.1.1.2				Production Acceptance Test	I			
4.1.1.3				Site Acceptance Test	I			
4.1.1.4				Verification Methods	I			
	a			Demonstration	I			
	b			Inspection	I			
	c			Analysis	I			
	d			Test	I			

Appendix D
Acronyms

Appendix E
Allowable Airborne Configurations

The airborne receiver is assumed to be operating fault free and meeting all the performance requirements in the LAAS MASPS. The airborne receiver is assumed to be computing the Lateral Protection Limit (LPL)/Vertical Protection Limit (VPL), as defined in Section 3.1.3.4.6 of the LAAS MASPS.

Section 3.1.2.3 is intended to satisfy the prior probability of a RR failure assumed in the H_1 VPL/HPL equation.

Section 3.2.1.2.7.3.1 (a) defines parameters for detecting a distorted GPS signal. The parameters are based on the airborne tracking constraints defined in Table E-1. This table defines the constraints for airborne equipment using early minus late or double delta delay lock loop discriminators to track GPS and SBAS ranging sources. Two additional constraints for double delta discriminators, not included in the table, are:

a. the aircraft receiver tracks the strongest correlation peak over the full code sequence for every ranging source used in the navigation solution; and

b. the pre-correlation filter rolls off by at least 30 dB per octave in the transition band.

Table E-1. Ranging Source Tracking Constraints

Ranging Source Discriminator	**3 dB Pre-correlation Bandwidth, BW**	**Average Correlator Spacing (chips)**	**Instantaneous Correlator Spacing (chips)**	**Differential Group Delay**
GPS/Early Minus Late	2<BW≤7 MHz	0.045-1.1	0.04-1.2	≤600 nsec
	7<BW≤16 MHz	0.045-0.21	0.04-0.235	≤150 nsec
	16<BW≤20 MHz	0.045-0.12	0.04-0.15	≤150 nsec
	20<BW≤24 MHz	0.08-0.12	0.07-0.13	≤150 nsec
GPS/Double Delta	2<BW≤7 MHz	0.045-0.6	0.04-0.65	≤600 nsec
	7<BW≤14 MHz	0.045-0.24	0.04-0.26	≤150 nsec

	14<BW≤16 MHz	0.07-0.24	0.06-0.26	≤150 nsec
SBAS/Early Minus Late and SBAS/Double Delta	2<BW≤7 MHz	0.045-1.1	0.04-1.2	≤600 nsec
	7<BW≤20 MHz	0.045-1.1	0.04-1.2	≤150 nsec

Figures E-1, E-2, and E-3 are representative of the Ranging Source Tracking Constraint requirements found in Table E-1.

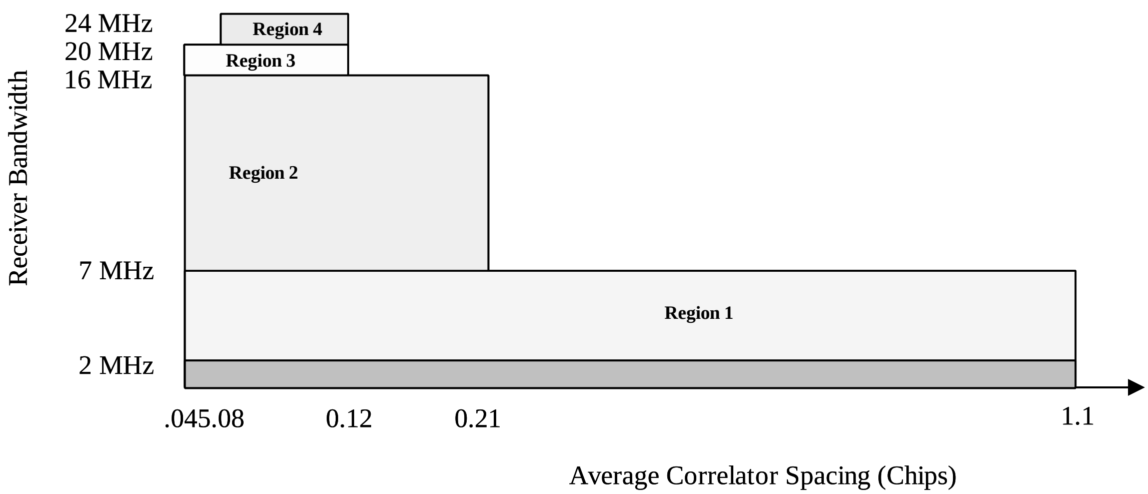


Figure E-1. Airborne Receiver Bandwidth vs. Average Correlator Spacing for GPS Early Minus Late.

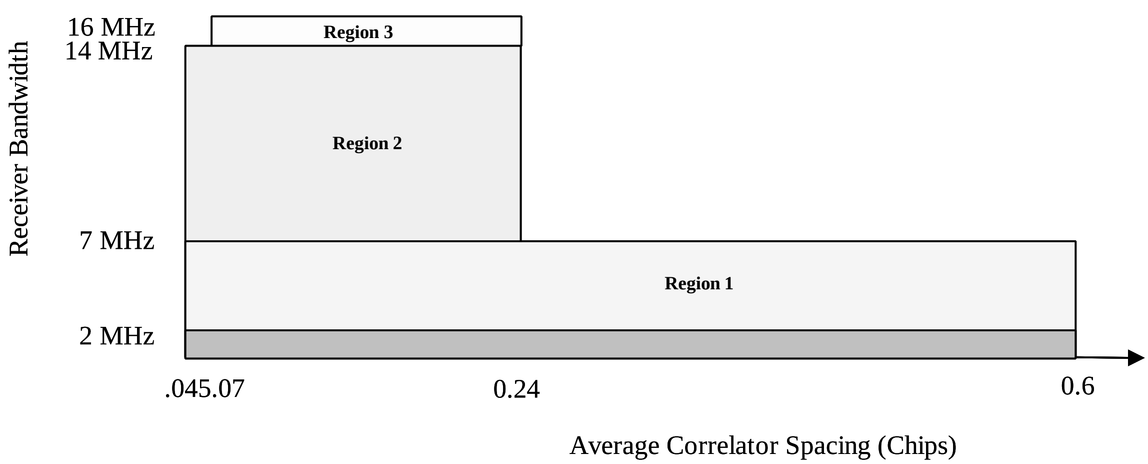


Figure E-2. Airborne Receiver Bandwidth vs. Average Correlator Spacing for GPS Double Delta.

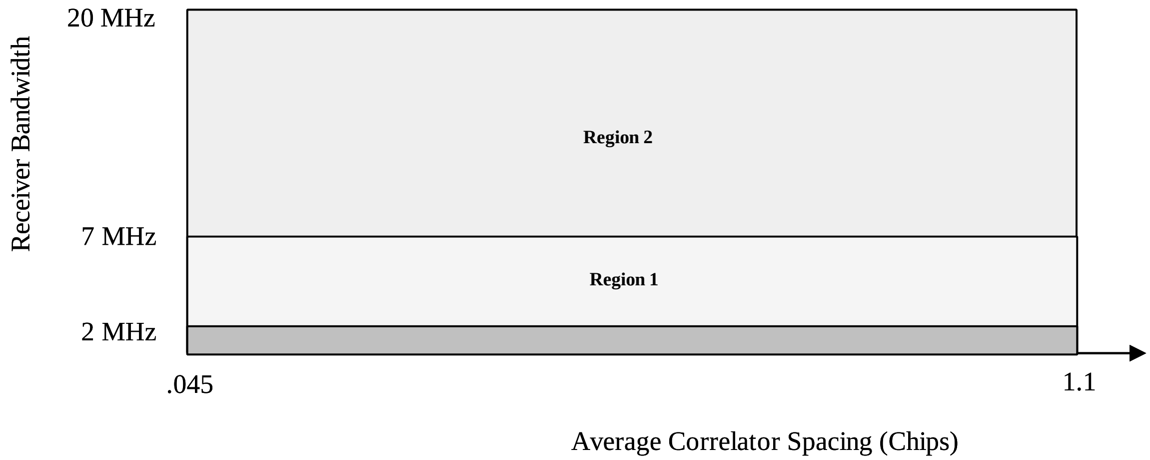


Figure E-3. Airborne Receiver Bandwidth vs. Average Correlator Spacing for SBAS Early Minus Late and SBAS Double Delta.

The instantaneous correlator spacing is defined as the spacing between a particular set of early and late samples of the correlation function. The average correlator spacing is defined as a one-second average of the instantaneous correlator spacing. The average applies over any one-second time frame.

The discriminator (Δ) is based on an average of correlator spacing within the specified range, or is a discriminator of the type $\Delta = 2\Delta_{d1} - \Delta_{2d1}$, with d_1 and $2d_1$ in the specified range. Either a coherent or a non-coherent discriminator may be used.

The differential group delay applies to the entire aircraft installed system prior to the correlator, including the antenna. The differential group delay is defined as

$$\left| \frac{d\,f}{dw}(f_c) - \frac{d\,f}{dw}(f_{3dB}) \right|$$

where f_c is the pre-correlation band pass filter center frequency,

f_{3dB} are the 3dB cut off points of the filter,

ϕ is the phase response of pre-correlation band pass filter, and

ω is the frequency.

Appendix F
Operational Considerations

This appendix describes operational considerations for LAAS that are an extension of the basic Category I level of service. Additional descriptions on tuning the LAAS approach and future applications can be found in the FAA LAAS Concept of Operations Document.

F - 1. PRE-FLIGHT PLANNING

Pre-flight planning should be similar to the requirements for current source referenced (VOR, DME, NDB, TACAN etc.) navigation and approach systems. This includes checking for service availability (e.g., satellite geometry), weather, alternate planning, and other similar actions to planning for the route of flight and destination. A NAS-wide information system (i.e., NOTAMS) distributes timely and consistent information across the NAS for both user and service provider planning.

The pilot should follow the specific start-up and self-test procedures for the GPS receiver as outlined in the FAA AFM or Flight Manual Supplement. Aircraft that are navigating by GPS are considered to be RNAV-equipped aircraft and the appropriate equipment suffix should be included in the Air Traffic Control (ATC) flight plan.

F - 2. TERMINAL

Terminal navigation operations are dependent upon the ability to position aircraft within the designated operational coverage of GPS/LAAS. GPS/LAAS may be tuned and used to correct aRrea NAVigation (RNAV) position during en-route and terminal operations using the Position, Velocity, and Time (PVT) output of the GPS/LAAS receiver in conjunction with a suitable RNAV system. The enunciated navigation source will indicate the lateral navigation mode, and that GPS/LAAS is selected and available.

F - 3. TUNING AND ANNUNCIATION

Pilots will select the LAAS/GPS approach for the runway of intended landing and tune the receiver to the LGF frequency to establish the data link (data channel), which provides the precision guidance for the GPS/LAAS final approach. After GPS/LAAS is tuned and the approach is selected, deviation indicators and the shortest distance for the aircraft to the threshold are displayed to the pilot. The display of deviation data is independent of the minimums to which the operation is being conducted. The needle sensitivity on the display indicator for both lateral and vertical deviations increases due to the emulation of an angular convergence of the localizer and glide slope origins.

F - 4. FLIGHT INSTRUMENT PRESENTATION

F - 4.1. Lateral Deviation

The LAAS airborne equipment provides proportional guidance for lateral course deviation and vertical path deviation within a ±35° lateral sector about the final approach path.

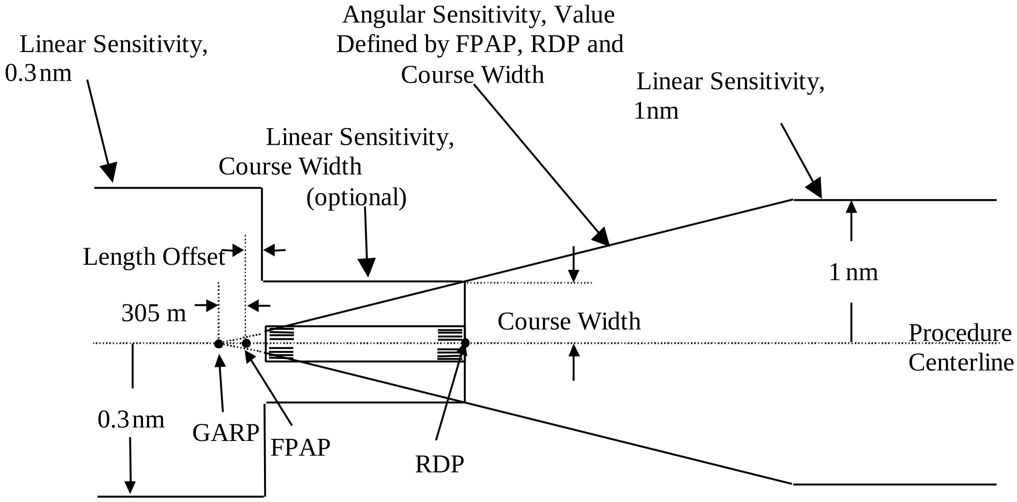


Figure F-1. Lateral Deviation

Lateral full-scale deviation can be based upon two independent characteristics, angular or linear. When an aircraft is outside of the 35° lateral guidance area, full-scale deviation is displayed. Lateral deviation, in all cases, is linear and has a width of ±1.0 nm to a point approximately 28 nm from the landing threshold. At this point, lateral deviation decreases angularly (at between 1.5° and 2.0°) to a point ±350 ft abeam the landing threshold. Lateral deviation at the threshold may continue either angularly or linearly. Angular lateral deviation mirrors current precision approaches to the departure end of the runway. Alternatively, lateral deviation may continue linearly, ±350 ft from the runway centerline to the departure end of the runway. At the departure end of the runway, lateral deviation is linear (±0.3 nm from the extended runway centerline) to a transition point (turn guidance, alternative clearance) or to the limits of the standard service volume.

F - 4.2. Vertical Deviation

The vertical path deviation display has a dynamic range less than or equal to

a. ±10 ft at runway threshold, increasing with along-track distance at a splay angle of ± the final approach segment glide path angle divided by four and

b. maximum deviation dynamic range is ±500 ft.

The resolution of the vertical path deviation data available for display is at least 1/256 of the full-scale deviation value. The vertical deviation display, as well as the display dynamic range, is updated at a minimum of 5 Hz.

F - 4.3 Distance

The distance to runway threshold display is displayed as the total distance from the aircraft measured position to the runway threshold, with a range of 60 nm and a resolution of 0.1 nm.

F - 5 LOSS OF GPS/LAAS GUIDANCE

During any phase of the LAAS Category I approach, when the LAAS service degrades to the level where the system can no longer provide lateral guidance, or lateral and vertical guidance with the required level of safety, the pilot is alerted that both the lateral and vertical guidance is invalid, consistent with the current presentations of the particular cockpit. Anytime an aircraft loses lateral guidance during an approach, the pilot will comply with missed approach instructions or proceed visually and notify Air Traffic Control (ATC).

In the event that the GPS/LAAS service degrades such that the vertical guidance can no longer be provided with the required level of service but the lateral guidance is valid, the pilot is alerted that the vertical guidance only is invalid. In this condition, the aircraft may continue the approach to the published lateral minimums.

F – 6. CATEGORY I PRECISION APPROACH OPERATIONS

The service provided by Category I precision systems ILS and MLS supports the standard decision height to 200ft (60m) and visibility to ½ statute mile (800m) or runway visual range (RVR) to 1800ft (550m). These systems will also support autoland and heads-up display (HUD) guidance systems to Category II minimums when authorized by appropriate Operations Specification. The service provided by LAAS will support the same minimums, operations, and procedures as current precision landing systems (ILS and MLS) including parallel dependent/independent operations.

F - 6.1. LANDING/ROLLOUT

Category I LAAS will support autoland for exercising system under Category I visibility conditions, unless otherwise stated on the published approach.

F - 6.2. CAT I MISSED APPROACH

During missed approach the GPS/LAAS flight instrument display will change from an angular to linear display with a $\pm$ 0.3 nm sensitivity and full scale deflection of the CDI when the aircraft position is past the LTP (i.e., when distance to LTP is a negative value), the Altitude is $\geq$ TDZE (or LTP altitude) plus 200 ft (CAT II), and glideslope deviation is $\geq$ 150 $\mu\alpha$ (full scale delection) above the center of the glideslope. This will be maintained to a transition point (turn guidance, alternative clearance) or to the limits of the standard service volume.

F - 6.3. LOSS OF GPS/LAAS GUIDANCE

For LAAS Category I approach, during any phase of the approach, when the LAAS service degrades to the level where the system can no longer provide guidance with the required level of safety, the pilot is to be alerted that the guidance is invalid, consistent with the current presentations of the particular cockpit.

In the event that the LAAS service degrades such that the vertical guidance can no longer be provided with the required level of safety; however, the aircraft is established on the approach on the glidepath, the aircraft may continue to published lateral minimums. If the lateral function does not meet operational requirements vertical and lateral guidance is "flagged" and the approach is discontinued. If the full LAAS capability is unavailable prior to glidepath intercept, the aircraft must revert to another form of navigation.

F – 6.4. DISPLACED THRESHOLD OPERATIONS

When an airport closes a segment of a runway, the landing threshold is displaced. Airport Management and Airway facilities prepare NOTAMS advising users of the runway status and appropriate NAVAID limitations. Under these conditions, Airway Facilities removes the vertical guidance until normal runway operations resume. If sufficient lead time is available, precision approaches to a displaced threshold can be flight checked for accuracy and implemented. This will increase CFIT protection by having a precision approach, as well as maintain airport capacity by enabling operations to continue without having to use a non-precision approach to the runway or changing to a non-optimum runway configuration.

The capability to remove vertical guidance allows for continued non-precision operations to a displaced threshold mirroring operations in today's air traffic management system

F - 7. LOW VISIBILITY SURFACE OPERATIONS

LAAS will support future capabilities for surface navigation and dependent surveillance for aircraft and vehicles. This capability is provided through the PVT output and requires an RNAV capability (e.g., GPS or FMS). Future LAAS-based ground navigation capabilities are anticipated to include the ability to provide specified paths points and instructions through the VHF Data Broadcast (VDB) data link, and communications with the ground controller through other digital data links.

The objectives of LAAS-based ground navigation in an Advanced Surface Movement Guidance and Control System (A-SMGCS) include:

a. improve airport safety by preventing runway incursion and aircraft conflicts;

b. improve airport capacity through the more efficient, direct, and coordinated paths to and from runways and gates;

c. achieve savings through reduced taxi times and provide the most efficient paths between runways and gates.

F - 8. USAGE OF LGF TEST AND ALARM INDICATORS

RTCA/DO-246A allows for several fields wherein an approach is deemed unusable. A description of those fields and there usage is described.

F - 8.1. Message Block Identifier

The message block identifier is part of the message header and is part of each message broadcast. For Performance Type 1 (PT1), the LGF will broadcast Type 1, Type 2 and Type 4 messages, as defined in DO-246A (unless noted otherwise). When the message block header is 1010 1010, it is an indication that the message can be used for navigation. When the message block header is 1111 1111, it is an indication that the message can not be used for navigation and is officially called "Test" in both DO-246A and the International Civil Aviation Organization (ICAO) Ground Based Augmentation System (GBAS) document. The LGF specification requires a

"Test Mode" in which test conditions can be run or the system is in undergoing maintenance that may cause the conditions of the LGF radiated signal to be out of tolerance. Flight inspection will have the capability to override the test message block header to flight check the LGF signal without concern that the flying public may use the signal, even if it is NOTAMed out. This is not as much of a concern for users wishing to fly an approach using the LGF signal, but more for operators in the en-route or terminal area that may be unaware of the NOTAM.

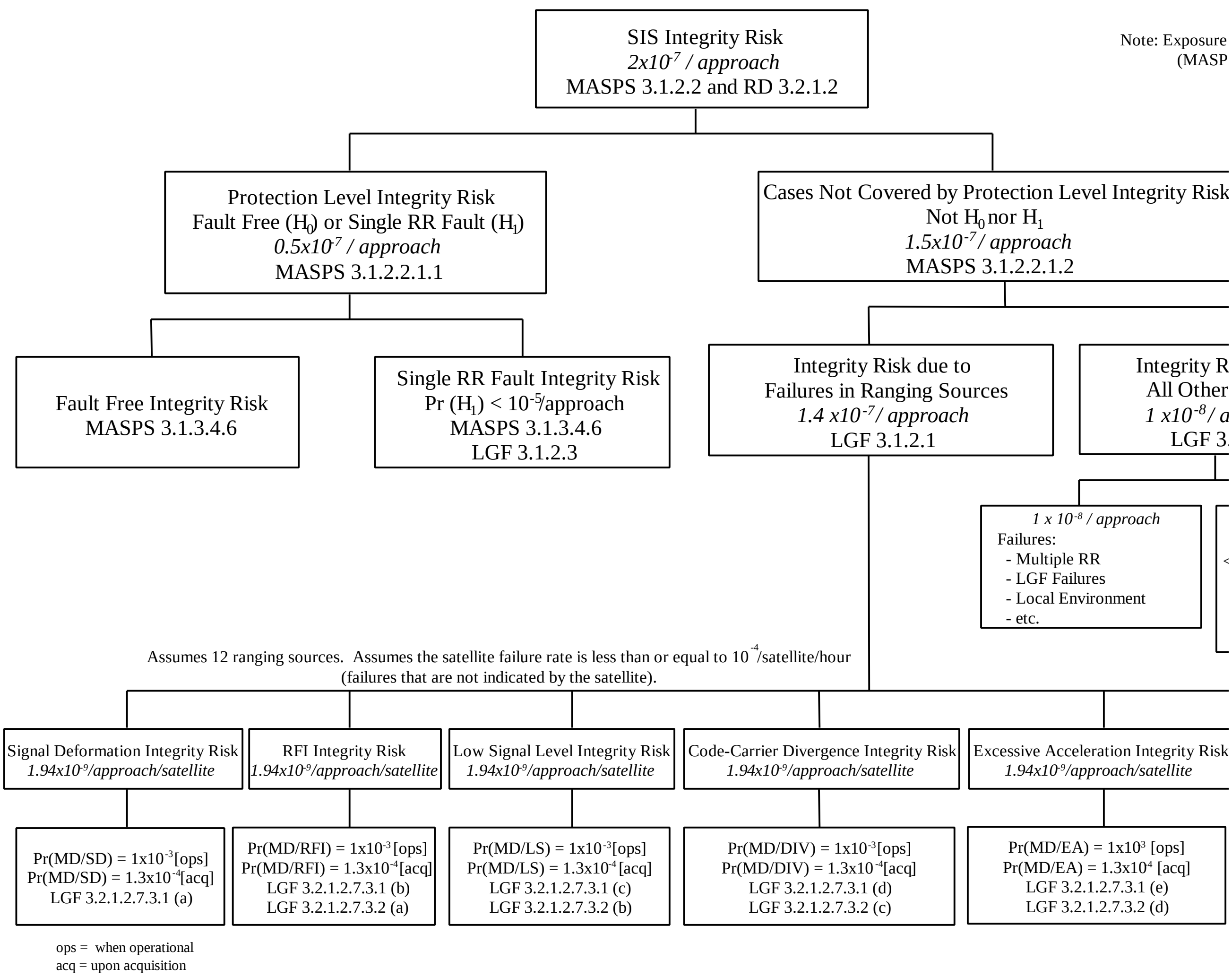
F - 8.2. Blank Type 1 Messages

The Type 1 message provides a "Number of Measurements" field which indicates the number of pseudorange corrections contained in the message. When this field is set to zero, the approach is immediately canceled (flagged) by the LAAS airborne receiver. This message field will be utilized to indicate an alarm at the LGF. The time from when the fault is detected to when it is annunciated at the aircraft includes the fact that the Type 1 message is broadcast at 2 Hz.

F - 8.3. Ground Continuity Integrity Designator

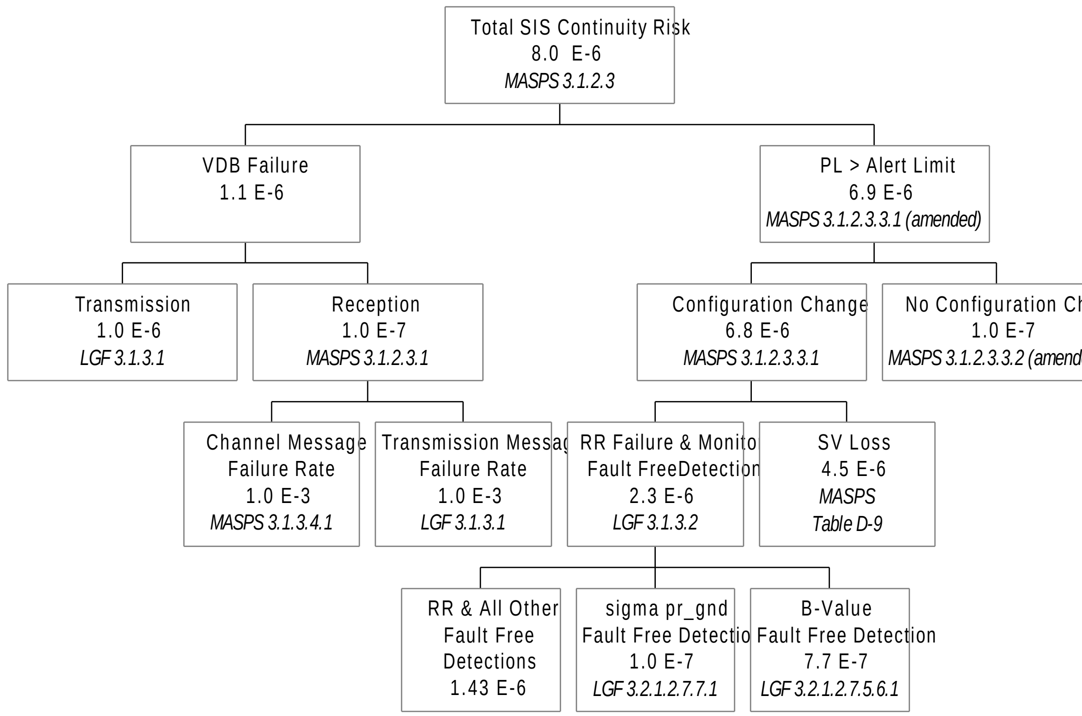
The Ground Continuity Integrity Designator (GCID) Field is contained in the Type 2 message and indicates the performance level of the approach. This specification addresses Performance Type 1 only, and is indicated in the GCID message field as 001. The LGF requires 111 to be indicated in the GCID message field when the ground station signal does not comply with PT 1 requirements for integrity. It is important to note that while the LGF may be in Test, the LGF can change the GCID according to the actual performance level of the signal. If a fault in the LGF has been corrected, maintenance or flight inspection may prefer to perform additional checks of the system while in Test, and a true indication from the GCID of the actual performance must be provided. If the GCID is broadcasting 001, for PT1, then maintenance will be assured that corrections are included in the broadcast and not have to monitor the VDB messages. Conversely, a GCID of 111 indicates that the system is still unusable and the Number of Measurements Field has been set to zero.

Appendix G
Risk Allocation Trees
Integrity Risk Allocation



F

Appendix G
Continuity Risk Allocations



Appendix H
Exceptions to the GNSS Based Precision Approach Local Area Augmentation System (LAAS)
Signal-in-Space Interface Control Document (ICD)

TYPE ONE MESSAGE*

Data Content	***Bits Used***	***Range of Values***	***Resolution***	***Bytes***
Modified Z-count	14	0 – 1,199.99	0.1 sec	-
Additional Message Flag	2	*0 – 3*	*1*	0
Number of Measurements	5	0 – 18	1	-
Measurement Type	3	0 - 7	1	1
Spare	*8*	-	-	*1*
Ephemeris CRC	16	-	-	2
Source Availability Duration	8	0 – 2540 sec	10 sec	1
For N Measurement Blocks:				
Ranging Source ID	8	1 - 255	1	1
Issue of Data (IOD)	8	0 - 255	-1	1
Pseudorange Correction (PRC)	16	±327.67 m	0.01 m	2
Range Rate Correction	16	±32.767 m/s	0.001 m/s	2
σ_{pr_gnd}	8	0 - 5.08 m	0.02 m	1
B_1	8	±6.35 m	0.05 m	1
B_2	8	±6.35 m	0.05 m	1
B_3	8	±6.35 m	0.05 m	1
B_4	8	±6.35 m	0.05 m	1
•				
Measurement Block N				

*Data that are all caps and bolded are message types that are worded differently in the LGF Specification or do not appear in the ICD. Data in italics either do not appear in the LGF Specification or reflect how the ICD is worded.

TYPE TWO MESSAGE*

Data Content	***Bits Used***	***Range of Values***	***Resolution***	***Bytes***
Ground Station Installed Receivers	2	– 2-4	-	-
Ground Station Accuracy Designator	2	-	-	-
(Spare)	*1*	-	-	-
Ground Station Continuity/Integrity Designator	3	0 - 7	1	1
Local Magnetic Variation	11	± 180°	0.25°	1
Spare	*5*	-	-	*2*
$s_{vert\_iono\_gradient}$	*8*	0-25.5 x10^{-6} m/m	0.1x10^{-6} m/m	*1*
Refractivity Index	8	16-781	3	1
Scale Height	8	0 – 25,500 m	100 m	1
Refractivity Uncertainty	8	0 - 255	1	1
Latitude	32	± 90.0°	0.0005 arcsec	4
Longitude	32	± 180.0°	0.0005 arcsec	4
Reference Point Height	24	± 83,886.07 m	0.01 m	3

*Data that are all caps and bolded are message types that are worded differently in the LGF Specification or do not appear in the ICD. Data in italics either do not appear in the LGF Specification or reflect how the ICD is worded.

TYPE FOUR MESSAGE*

Data Content	***Bits Used***	***Range of Values***	***Resolution***	***Bytes***
Data Set Length	8	2 – 212	1	-
FAS Data Block	304	-	-	-
Operation Type	4	0 – 15	1	-
Reserved **SBAS PROVIDER ID**	4	0 – 15	1	1
Airport ID	32	-	-	4
Runway Number	6	0 – 36	1	
Runway Letter	2	-	-	1
Approach Performance Designator	3	0 – 7	1	-
Route Indicator	5	-	-	1
Reference Path Data Selector	8	0 – 48	1	1
Reference Path Identifier	32	-	-	4
LTP/FTP Latitude	32	± 90.0 °	0.0005 arcsec	4
LTP/FTP Longitude	32	± 180.0 °	0.0005 arcsec	4
LTP/FTP Height	16	-512.0 - 6041.5 m	0.1 m	2
Delta FPAP Latitude	24	± 1.0 °	0.0005 arcsec	4
Delta FPAP Longitude	24	± 1.0 °	0.0005 arcsec	4
Approach Threshold Crossing Height (TCH)	15	0 – 3,276.7 ft 0 – 1,638.35 m	0.1 ft 0.05 m	-
Approach TCH Units Selector	1	-	-	2
Glidepath Angle (GPA)	16	0 - 90.0 °	0.01°	2
Course Width	8	80 – 143.75 m	.25 m	-
Delta Length Offset	8	0 – 2,032 m	8 m	-
Final Approach Segment CRC	32	-	-	4
FAS VAL/Approach Status	8	0 – 25.4 m	0.1 m	-
FAS LAL/Approach Status	8	0 – 50.8 m	0.2 m	-

*Data that are all caps and bolded are message types that are worded differently in the LGF Specification or do not appear in the ICD. Data in italics either do not appear in the LGF Specification or reflect how the ICD is worded.

Appendix I
Final Approach Segment – Definitions

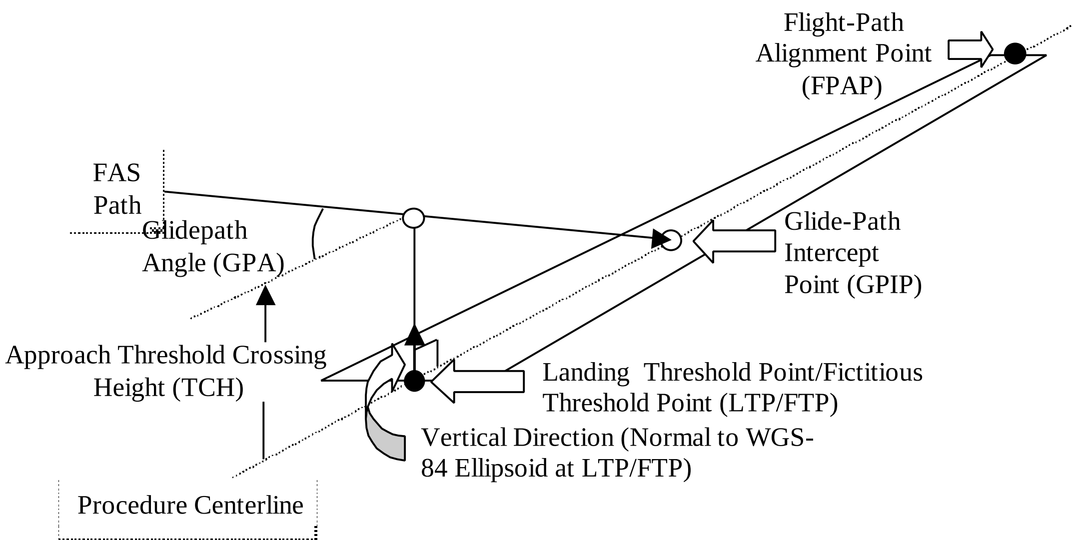


Figure I-1. Final Approach Segment Diagram

I – 1. Final Approach Segment Path Definition

The Final Approach Segment (FAS) path is a line in space defined by the Landing Threshold Point/Fictitious Threshold Point (LTP/FTP), Flight Path Alignment Point (FPAP), Threshold Crossing Height (TCH) and the Glide Path Angle (GPA). The local level plane for the approach is a plane perpendicular to the local vertical passing through the LTP/FTP (i.e., tangent to the ellipsoid at the LTP/FTP). Local vertical for the approach is normal to the WGS 84 ellipsoid at the LTP/FTP. The Glide Path Intercept Point (GPIP) is where the final approach path intercepts the local level plane.

I – 2. LTP/FTP Definition

The Landing Threshold Point/Fictitious Threshold Point (LTP/FTP) is a point over which the FAS path passes at a relative height specified by the threshold crossing height. It is normally located at the intersection of the runway centerline and the threshold.

I – 3. Final Path Alignment Point Definition

The Flight Path Alignment Point (FPAP) is a point at the same height as the LTP/FTP that is used to define the alignment of the approach. The origin of angular deviations in the lateral direction is defined to be 305 meters (1000 ft) beyond the FPAP along the lateral FAS path. For an approach aligned with the runway, the FPAP is at or beyond the stop end of the runway.

Appendix J
Documentation for the LGF

Design oriented documentation:

a. System functional & performance spec with requirements verification matrix traceable to FAA LGF specification

b. ICDs for external interfaces, including LGF, MDT, LSP, RSP and ATCU

c. Test plans and procedures for DT, PAT, SAT, and OT&E and type acceptance for non-federal certification.

Installation and maintenance oriented documentation:

a. Installation drawings (including information necessary to physically site and operate an LGF (including RSP & ATCU) installation) in accordance with FAA-STD-002.

b. Technical Instruction Books (TIB) in the same order and containing the same information as FAA TIBs and in accordance with Technical Instruction Book Manuscripts: Electronic Equipment Requirements for Part - Preparation of Manuscript, FAA-D-2494B.

c. Training Plans